SPEEDOMAX® TYPE G RECORDERS
MODEL S 60000 SERIES

LEEDS NORTHRUP
PHILADELPHIA 44, PA.

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SPEEDOMAX TYPE G RECORDERS

MODEL S 60000 SERIES

INTRODUCTION

These directions cover the general mechanical and electrical features of the Speedomax Type G, Model S, 60000 Series Recorders. Special features, peculiar to certain recorders, are covered in individual directions sent only with the particular recorders.

Although Part I of these directions covers the data essential to placing the recorder in service, it is suggested that the applicable sections of Part IV be read, as soon as possible, to assist in understanding the operation of the instrument.

Another suggestion is that the serial number of the recorder be furnished whenever data or spare parts are requested. This will materially aid in expediting the work at the factory. The number is included on the nameplate on the floor of the case. (On earlier models the serial number may have been stamped, (1) behind the latch on the left side of the main frame casting, (2) on the edge of the gear box under the motor, or (3) on the boss at the side of the gear box.) Some recorders have the letter A prefixed to the serial number. Be sure to include this letter, when it occurs, as it has a definite significance in respect to the main frame casting, the latching device, paper drive gearing arrangement, and the type of fuses used.

PART I

PREPARE RECORDER FOR SERVICE

1. MOUNT THE RECORDER

The recorder is, unless otherwise specified, arranged for flush mounting on a panel by means of four mounting bolts as indicated in the separate drawing showing the outline and drilling dimensions. The mounting bolts are packed with the accessories.

When specially ordered, the recorder can be arranged for surface mounting (by means of two hangers fastened to the back of the recorder) or for use in shock proof mountings. In either case the method of mounting and the dimensions are shown in a separate drawing.

2. TAGS ATTACHED TO RECORDER

Directions given on tags attached to the recorder should be carefully followed and all tags removed.

3. PRECAUTIONS FOR STANDARD CELL

Recorders using a potentiometer type measuring circuit are furnished with a standard cell 26, Fig. 3.

The standard cell should never be exposed to temperatures below 32 F or above 140 F. In order to satisfy this requirement the recorder, on continuous operation, should not be installed in locations where the ambient temperature in the room is below 10 F or above 120 F. If it is necessary to use the recorder where the temperature is outside these limits, remove the standard cell, place it where the temperature will be within the limits specified and run twisted leads from the recorder to the standard cell. Both the standard cell and the leads should be shielded and the shielding grounded. Be sure the polarity connections are made the same as the original connections and mount the cell in the same position as when in the recorder. Also be sure not to short circuit the cell at any time. Do not stand the standard cell on its side or inverted when in use.

The recorder is shipped with the automatic current adjuster stopped with the standard cell circuit open so as to be certain that there will be no current drain from the standard cell. However, no preliminary adjustment is necessary at this point.

The recorder should not be stopped, for an extended period, with the automatic current adjuster in the operating (standard cell) position. To check this position, swing out the chart assembly as directed in Section 4. Then slightly rotate the split gear 65, Fig. 25, and at the same time observe rheostat 93, Fig. 25, for any movement. If this rheostat moves, the automatic current adjuster is in the operating position and the recorder

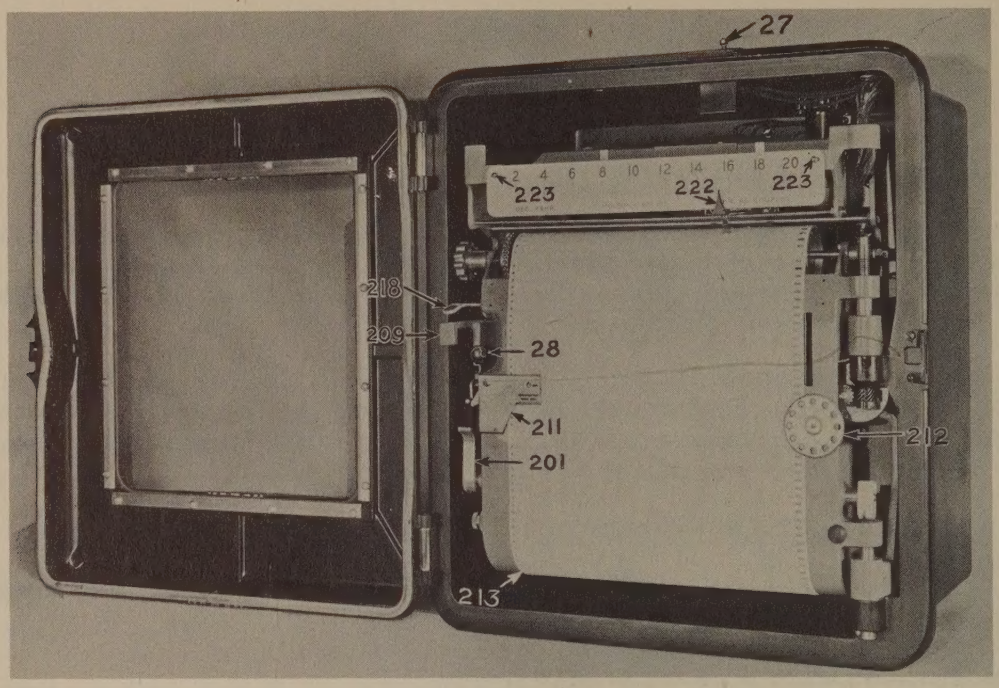

Fig. 1—Interior with hinged castings latched in operating positions.

should be operated until no movement of rheostat 93 is obtained when the split gear is rotated, and then stopped.

4. SWING OUT CHART ASSEMBLY

Open the door as in Fig. 1. Then grasp the top of latch 201, Fig. 1, between the thumb and the index finger. Pull forward and downward to swing the top of this latch through an arc of approximately 90 degrees (as far as it will go). The casting containing the paper drive, reroll, etc., then will be lowered and unlatched. Pull forward on latch 201 to swing the assembly out as shown in Fig. 2.

5. CHART

A. Install

The new roll of chart paper should be placed in position at A, Fig. 2. Hold the paper roll with the edge containing the circular holes to the right hand side when viewed as in Fig. 2. All references are to Fig. 2 unless otherwise noted. Pull out knob 202 as far as it will go. Fit the right hand end of the tube, in the new paper roll, on the flange at 203. Then allow knob 202 to spring slowly back into place and at the same time fit the left hand end of the tube on the flange at 204.

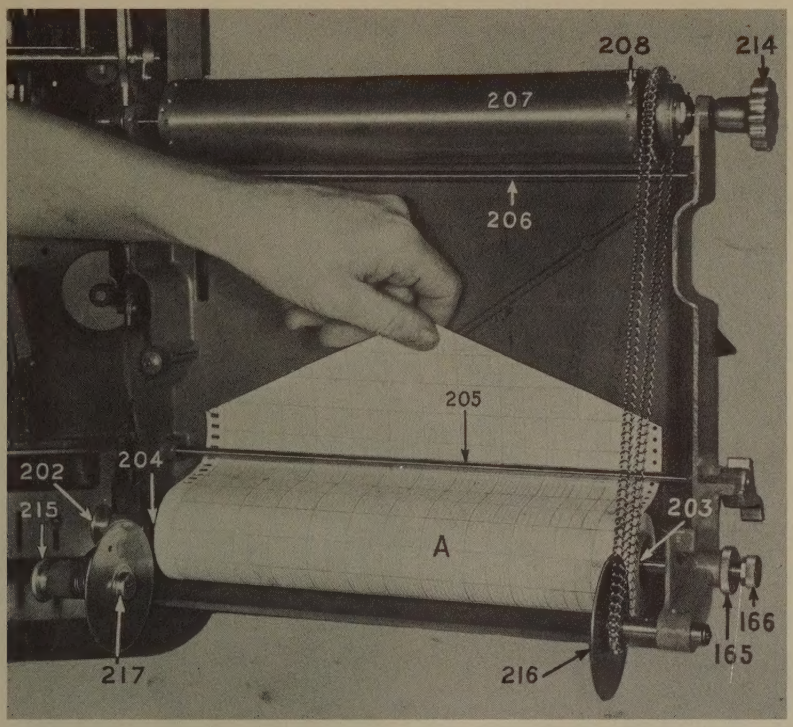

Fig. 2—Rear view of chart mechanism hinged casting.

Thread the end of the paper up and back of guide rod 205. Carry the paper up to and back of guide rod 206. Then thread the paper between the top of guide rod 206 and the bottom of drive roll 207. Pull the paper through until approximately 12 inches extend beyond guide rod 206.

Then carry the paper up and over drive roll 207 to the front of the drive roll. In doing this be sure to keep the horizontal lines on the paper parallel to the axis of the drive roll and at the same time fit the pins of the drive roll at 208 carefully into the circular holes in the right hand edge of the paper and the slots on the pins at the left hand end.

Swing the chart assembly to the left so as to be able to continue with the paper on the front as in Fig. 1. Then carry the paper down the front as in Fig. 1. In doing this be sure that the paper is threaded under indicator arm 211, Fig. 1, and the signal disk 212, Fig. 1.

Carry the paper under the bottom of the chart assembly casting as at 213, Fig. 1, and over to the reroll tube which is to be mounted between flanges 216 and 217. Turn knob 214 to feed the paper. The reroll tube is the red fiber tube, with a slot in each end, packed with the accessories. To place this tube in position, pull out knob 215 and fit one end of the reroll tube on the flange at 216 so that the arm on this flange fits in the slot of the reroll tube. Then allow knob 215 to spring slowly back into place and

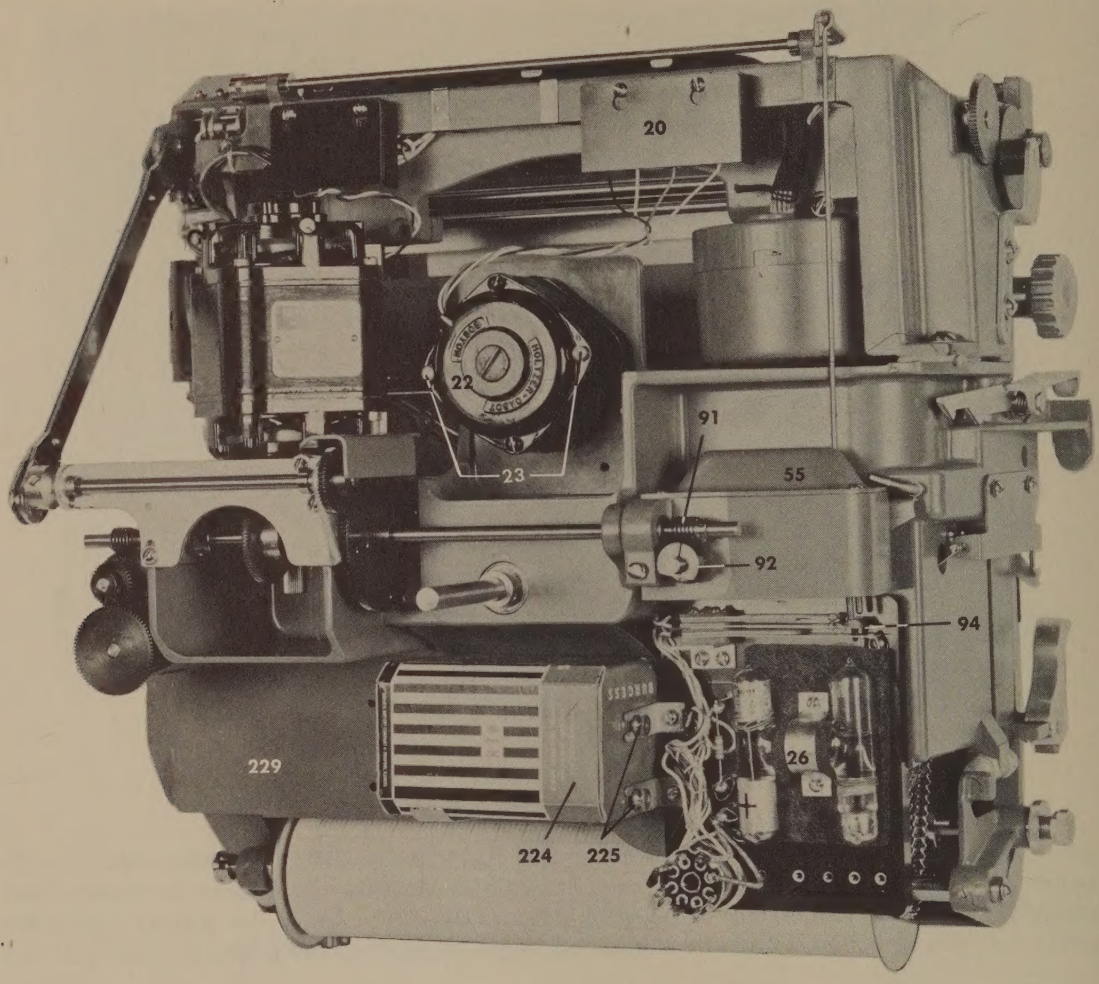

Fig. 3—Front view of main hinged casting.

at the same time fit the left hand end of the tube on the flange at 217.

Continue with the paper across the bottom of the chart assembly casting to the reroll tube. Carry the paper under the reroll tube and halfway around the tube. Draw the paper tight enough to make it smooth down the front of the assembly as in Fig. 1 and then use a gummed label (furnished with the accessories) to fasten the paper to the reroll tube.

The right hand end of the chart roll at 203 should be adjusted so that there is approximately 1/32" clearance between this end of the chart roll and the inside face of flange 216. If this condition does not exist, loosen knurled nut 165 a slight amount and turn nut 166 until the above condition is obtained.

As a final check, turn knob 214 to feed paper. During this check be sure that the pins, at both ends of the drive roll, fit into the holes in the edges of the paper, that the horizontal lines on the paper are parallel to the axis of drive roll 207, and that the paper lies flat against the front of the chart assembly casting.

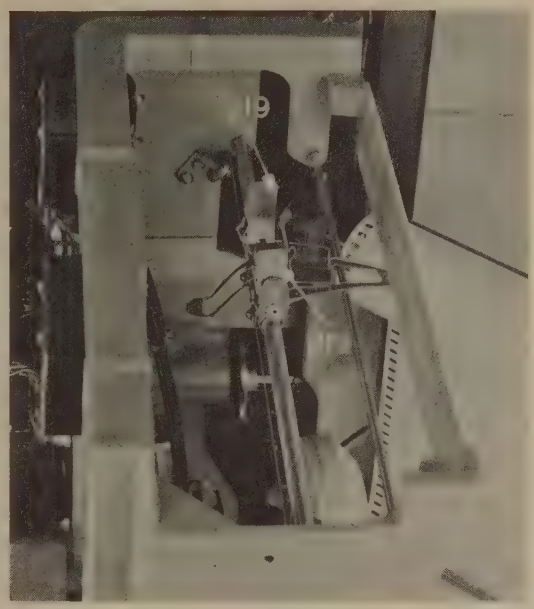

Fig. 4—Pen carriage with pen clip in place (viewed from the top).

B. Change Speed

The speed of travel of the chart can be changed by substituting different gears in certain places in the gear train. When the recorder is furnished for only one chart speed, and at a later date a different speed is desired, the necessary gears may be ordered from Leeds & Northrup Company for the new speed.

On the other hand, a recorder may be furnished, when so ordered, with additional gears for obtaining several different chart speeds. In such a case, the recorder is shipped with one set of gears mounted in place for operation. The gears for the other speeds are furnished in a box which is fastened, in the majority of instances, to the bottom of the motor gear housing by means of a thumbscrew. In addition, a label, containing a drawing and table showing chart speeds, gears required and their locations, is pasted inside the recorder case on the right hand side. Thus, the gears required for a given chart speed can be identified from this label. All gears are numbered according to the label.

This specific method of obtaining various chart speeds is limited to recorders with the letter A prefixed to the serial number.

6. SWING OUT OPERATING MECHANISM ASSEMBLY

It is necessary to release latch 218, Fig. 1, in order to swing out the operating mechanism assembly. To do this, hook the index finger under the extension 209, Fig. 1, press latch 218 down with the thumb and, with the latch held down, pull forward with the index finger to swing the mechanism out as in Fig. 3. With the chart assembly latched in place as in Fig. 1, both assemblies can be swung out as a unit by the above operation.

7. PREPARE INKING DEVICE

A. Pen (Curve Drawing Single Point Recorders)

In handling the pen be careful not to bend the point.

Fig. 5—Pen mounted in its clip.

Fig. 6—Filling pen with ink.

Remove the metal clip, which holds the pen in the pen carriage, from the pen carriage. To do this, press arms 219, Fig. 4, a slight amount toward each other and at the same time lift the clip from the carriage. Then place the pen in the clip as shown in Fig. 5 and check to be sure that the arm of the pen fits snugly in the notch 220, Fig. 5.

If the rubber stopper (containing a breather hole) is supplied, it must be removed from the bowl of the pen for the filling operation. Hold the pen as in Fig. 6, and fill it with ink to the level shown in the figure. Replace the rubber stopper, where used.

Swing out the chart assembly and place the pen and clip in the pen carriage as shown in Fig. 7.

With the chart assembly swung out, manually rotate split gear 65, Fig. 25, to move the indicator 222, Fig. 1, toward the low end of the scale until the stop is reached in this direction. When the chart assembly is closed and latched, the pen point should be on the low end line of the paper chart. If this is not the case, loosen the two screws 221, Fig. 8, to release the pen carriage from the drive cord and move the pen carriage until the pen point is on the end line of the chart. Then tighten the two screws 221.

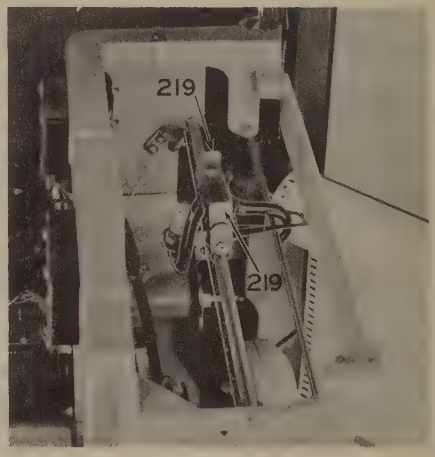

Fig. 7—Pen mounted in carriage (viewed from the top).

After the above adjustment is completed, keep the pen on the low end line of the paper chart. When in this position the indicator 222, Fig. 1, on the pen carriage should be in line with the last line on the indicating scale.

If this is not the case, loosen the screws 223, Fig. 1, and slide the scale until the last line at the low end lines up with the indicator on the pen carriage. Then tighten the screws 223 to hold the scale in this position.

The indicator 222, Fig. 1, may rub against the bottom of the scale or the pen may not make satisfactory contact with the chart. To correct, lower the chart assembly but do not swing it out. Then loosen screw 170, Fig. 17-B, and adjust knurled head screw 171 so that the indicator clears the scale and the pen makes satisfactory contact with the chart when the chart assembly is raised.

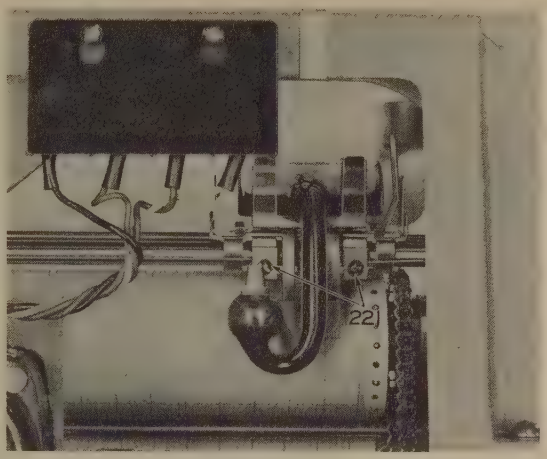

Fig. 8—Pen mounted in carriage (viewed from the rear).

If the pen fails to draw a line, moisten a finger and draw it across the pen point. If this procedure fails, clean the pen as directed in Section 24.

B. Ink Pads (Multiple-Point Recorders)

Multiple-point recorders are furnished with the necessary ink pad (unicolor) or pads (multicolor) properly impregnated with ink and mounted in place ready for service. These pads will, of course, gradually become dry and in time will wear out.

To re-ink the pads, refer to Section 18.

To replace the pads with new ones, refer to Section 19.

With the chart assembly swung out, manually rotate split gear 65, Fig. 25, to move the indicator 222, Fig. 1, toward the low end of the scale until the stop is reached in this direction. Then close and latch the chart assembly. Under these conditions, the indicating pointer on the print wheel carriage should be at the end line at the low end of the indicating scale. If this condition does not exist, loosen screw 221-B, Fig. 9, and similar screw at opposite side, to release the print wheel carriage from the drive cord and move the print wheel

Fig. 9—Multicolor print wheel carriage (partial rear view).

carriage until the above condition does not exist. Then tighten the two screws to hold the print wheel carriage in place.

Operate the mechanism to print points at several places along the chart. Two conditions may exist. The numerals may be printed satisfactorily on one side of the chart but not on the other side. To correct this condition, loosen the screws in the slotted holes of the printing plate and carefully shift one side up or down slightly until uniform printing across the chart is obtained. If only the upper or lower half of each numeral is printed uniformly, along the entire width of the chart, the entire chart assembly should be raised or lowered slightly. Refer to Fig. 17-B. Lower the chart assembly but do not swing it out. Then loosen setscrew 170 on the lower hinge post and adjust the knurled screw 171 to raise the assembly if only the upper half of the numerals print or to lower the assembly if only the lower half of the numerals print. Retighten the setscrew.

8. INSTALL DRY CELL

This procedure is necessary where a dry cell is used to supply current to the measuring circuit. In such instances a Burgess, Little Six dry cell is shipped unmounted and should be installed as shown at 224, Fig. 3. To do this, place the cell in the spring clips of the mounting and then fasten the terminals of the cell to the terminals at 225, Fig. 3. A standard No. 6 dry cell may be used when no interrupters are mounted at 229, Fig. 3.

9. AMPLIFIER

The amplifier is shown at 10, Fig. 10. To have access to this unit, swing out the operating mechanism as directed in Section 6.

Check the converter 11, all tubes, and the plugs 12, 13, and 14, Fig. 10, to be sure that they fit tightly in their respective sockets.

For more detailed data on the amplifier, refer to Section 32.

10. WIRING CONNECTIONS

The detailed wiring connections for each recorder are shown in the diagram sent with the instrument. All connections should be made according to this diagram.

The marking 115 V 60 ~ G or 115 V 60 ~ MG, on the terminal block at one of the motor leads, does not signify that this lead must be connected to ground but simply designates the lead which should be connected to the grounded side of the power supply.

Where the recorder is used to measure the temperature of electrical apparatus and where the measuring circuit will permit, it is recommended that one side of each detecting element be grounded at the electrical machine in order to protect both personnel and recorder in case of high voltage breakdown to a detecting element.

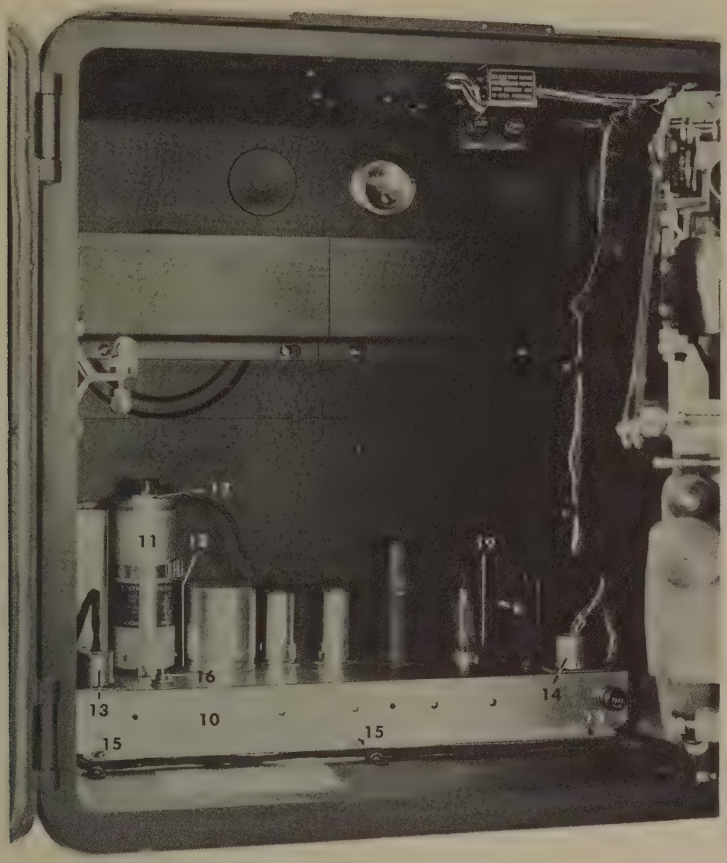

Fig. 10—Inside of case showing amplifier.

It is suggested that the recorder case be connected to ground.

11. INITIAL LUBRICATION

The recorder has been properly cleaned and lubricated before leaving the factory. However, there are certain points which should be lubricated before placing the recorder in service. These points are indicated by ◑ in Fig. 17-A to 17-E, inclusive.

Use a good grade, medium weight oil. Apply one or two drops of oil at each point and remove any excess oil.

12. SENSITIVITY AND DAMPING ADJUSTMENTS

The sensitivity is adjusted by means of the rheostat 16, Fig. 10. This adjustment is made at the factory and normally will not require readjustment.

The optimum sensitivity setting is that setting which gives maximum sensitivity without causing "hunting" (pen oscillation) about the balance point. If oversensitivity (characterized by "hunting") or insensitivity (characterized by objectionable width of dead band when coming into balance from opposite ends of scale) is noted, turn the sensitivity rheostat clockwise as far as possible; then turn it slowly counterclockwise until the "hunting" disappears or shows as only a very slight wiggle in the motor pinion 24, Fig. 25.

Instruments arranged to balance in one second are provided with a damping rheostat. This rheostat is located on the horizontal rib of the casting to the right of the balancing motor. After adjusting the sensitivity rheostat as indicated above, adjust the damping rheostat for proper damping of balancing motor. Underdamping is characterized by overshoot of the balance point. When overdamped the pen will approach the balance point too slowly and in many small steps.

13. ADJUST CURRENT OF POTENTIOMETER CIRCUIT

A. With Automatic Current Adjuster

The automatic current adjuster is arranged to automatically adjust the current once in approximately every 48 minutes while the recorder is operating. The operation of the automatic current adjuster is described in Section 37.

However, when a new dry cell, for the measuring circuit, is installed the current should be adjusted semi-automatically as follows:

Start the recorder operating by snapping switch 27, Fig. 1, to the ON position, and allow sufficient time for the tubes in the amplifier to warm up. Then turn knob 28, Fig. 1, in the direction indicated by the arrow, as far as it will go and hold it in this position until the pen or print wheel carriage does not move (current balanced). Release knob 28. If the pen or print wheel carriage should travel to either end of the scale before it comes to rest, release knob 28, wait a few seconds for the pointer to travel towards mid scale (or manually move the main shaft to obtain this condition) and then again proceed as indicated above. The current in the potentiometer circuit is now properly adjusted and the automatic mechanism will act to check and readjust the current once in approximately every 48 minutes.

B. With Semi-Automatic Current Adjuster

The automatic adjustment of the current, once every 48 minutes, is not included in this arrangement. The current must, therefore, always be adjusted semi-automatically as follows:

Start the recorder mechanism operating by snapping switch 27, Fig. 1, to the ON position and allow sufficient time for the tubes in the amplifier to warm up. Then turn knob 28, Fig. 1, in the direction indicated by the arrow,

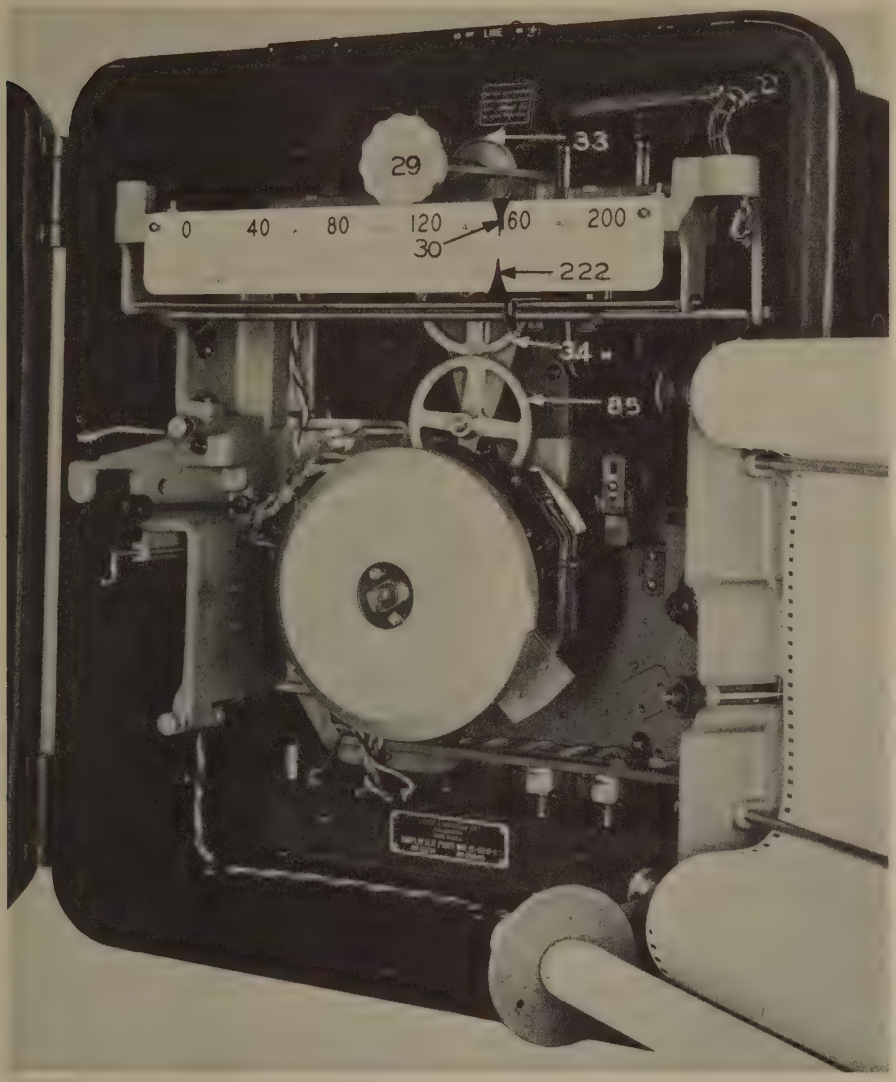

Fig. 11—Rear view of main hinged casting with manual contact setter mechanism.

as far as it will go and hold it in this position until the pen or print wheel carriage does not move (current balanced). Release knob 28. If the pen or print wheel carriage should travel to either end of the scale before it comes to rest, release knob 28, wait a few seconds and then proceed as indicated above. The current in the potentiometer circuit is now properly adjusted. This same procedure must be followed for each adjustment of this current.

14. CHECK AND SET CONTROL DISKS AND CONTACTS (EXPOSED TYPE)

When a recorder is equipped with control disks and contacts, the

setting of such parts should be checked before placing the recorder in service. Various arrangements of control disks and contacts may be furnished for varied applications. Figs. 11 and 12 show a common arrangement of two exposed type contacts equipped with a setting device and arranged for maximum and minimum control. This equipment will be used as an illustration for making such a check.

Swing out the chart assembly. Then rotate split gear 65, Fig. 25, until the black indicator 222, Fig. 11, is at a major scale division near the center of the scale. Keep the black indicator at this point and turn dial 29, Fig. 11, until both contacts on block 88, Fig. 12, are open. Under this condition the red indicator 30, Fig. 11, should be at the same point on the scale as the black indicator.

If the red indicator is off a slight amount, loosen the screw in the clamp of the red indicator on the drive cord and shift the red indicator to the proper point on the scale. Then tighten the clamp screw to hold it in place.

If the red indicator is off a large amount, adjust the disks as directed in Section 39.

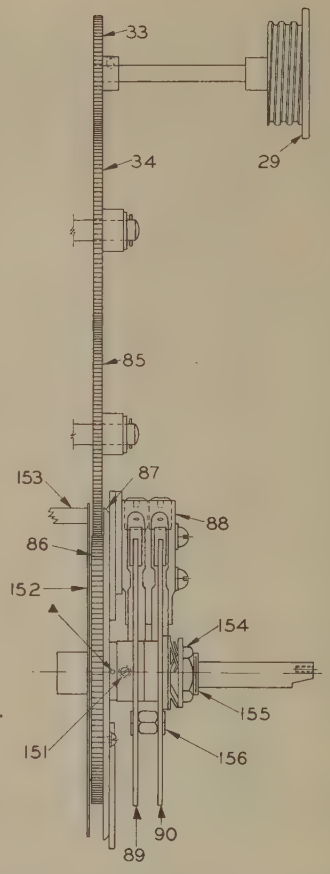

Fig. 12—Details of manual contact setter mechanism.

After the above check has been completed, turn dial 29, Fig. 11 (or the knob on the outside of the recorder case) to set the indicator 30, Fig. 11, at the value on the scale for which the instrument is to control.

15. CHECK AND SET CONTROL DISKS AND CONTACTS (ENCLOSED TYPE)

Enclosed type contacts are arranged and actuated by control disks in the same manner as the exposed type contacts described in Section 14 and illustrated in Figs. 11 and 12.

To check the contact setting proceed as follows: Turn dial 29, Fig. 11, until the red indicator is at a major scale division near the center of the scale. Then with the chart assembly swung out, rotate the split gear 65, Fig. 25, until the black indicator is positioned, with respect to the red indicator, at the point at which the contact is to operate. For example, if the contact is to be set to operate at the control point, set the black indicator opposite the red indicator. If on the other hand the contact is to operate

at some fixed point below or above the control point, set the black indicator at that point on the scale. When the indicators are properly positioned the actuating flipper on the enclosed type contact should be midway on the slope of the notch in the control disk. If these conditions do not exist, adjust the disk or disks, as directed in Section 40.

After the above check has been completed, turn dial 29, Fig. 11 (or the knob on the outside of the recorder case) to set the indicator 30, Fig. 11, at the value on the scale for which the instrument is to control.

PART II

SERVICING UNDER NORMAL OPERATING CONDITIONS

16. INSTALL NEW CHART

To remove the used roll of paper, pull knob 215, Fig. 2, out and lift the roll from the drive end at 216.

Install a new chart as directed in Section 5.

When ordering paper, specify the paper number, which is found on the scale strip. Also, when the paper is time stamped, indicate how it is time stamped. This will facilitate handling of the order.

17. REFILL THE PEN

When the ink in the front part of the pen drops below the level of the indicator punching, the pen should be refilled. To do this, lift the clip and pen, as a unit, from the recorder. Fill the pen as directed in Section 7-A and replace the pen and clip unit in the recorder.

18. RE-INK THE PADS

When the impressions on the chart become faint, the ink pad or pads should be re-inked, or replaced by new pads if badly worn. To replace the pads, proceed as directed in Section 19. To re-ink the pads, proceed as follows:

A. Unicolor

Stop the recorder. Use a small piece of wood (such as a match stick) flattened at one end to transfer the ink from the bottle to the pad. Place a small amount of ink on a small area of the periphery of the ink pad and allow it to soak into the pad. Proceed in this manner around the periphery of the pad until the pad will absorb no more ink. Remove any excess ink from the pad with a blotter.

B. Multicolor

Use a small piece of wood (such as a match stick) flattened at one end to transfer the ink from the bottle to the pads. In applying the ink do not use a wet stick of one color ink for a different color and be sure that ink of one color does not flow over to a pad containing a different color ink. Apply a small amount of ink (of the proper color) to the pad and allow it to soak into the pad. Repeat this procedure until the pad will absorb no more ink. Remove any excess ink with a blotter.

The pad wheel can be rotated manually by turning gear 53, Fig. 13, in a counterclockwise direction. Rotate the pad wheel as desired and apply ink to the successive pads.

Fig. 13—Showing gear, of multicolor recorder, to turn for manual operation of ink pad wheel.

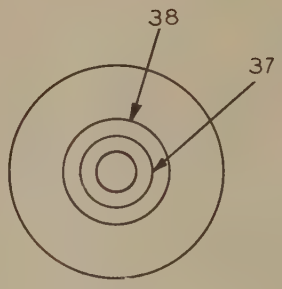

Fig. 14—Details of unicolor ink pad wheel.

19. INSTALL NEW INK PADS

A. Unicolor

To install a unicolor ink pad, remove thumb nut 37 and washer 38, Fig. 14, from the ink pad shaft. Then lift the ink pad from the shaft. Be sure to use a blotter and remove any excess ink from the new pad and then fit it in place on the bearing. Replace the washer and thumb nut.

B. Multicolor

To install multicolor ink pads, proceed as follows:

Loosen the knurled head screw 34, Fig. 15, and lift the wheel 35, Fig. 15, free of the mechanism. Then remove the plate from the back of the wheel. To do this, loosen screws 39, Fig. 16, turn plate 40, Fig. 16, so that the screws 39 fit in the holes 41 and lift plate 40 from the wheel. The ink pads can now be readily removed and new ink pads put in their places, or, for the first replacement, the used pads may be turned so that the bottom face will be exposed for inking and then replaced in the wheel.

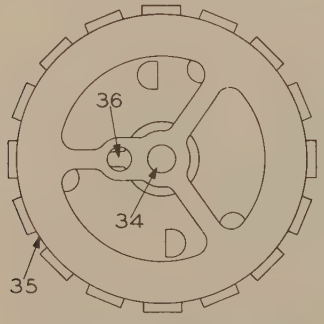

Fig. 15—Details of multicolor ink pad wheel (front view).

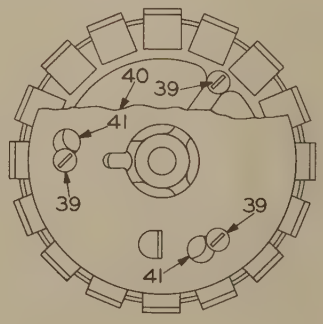

Fig. 16—Details of multicolor ink pad wheel (rear view).

When installing new pads, be sure and use a blotter to remove any excess ink from the pads before placing them in service.

After the ink pads are in position in the wheel, replace the plate 40, Fig. 16, and tighten it in place with screws 39. Then replace the pad wheel in the recorder. To do this, fit the guide pin in hole 36, Fig. 15, and the end of screw 34 into the hole in the support. Then tighten screw 34 to hold the wheel in place.

20. CLEANING AND LUBRICATING

This recorder is a continuously operating mechanism and as such requires occasional cleaning and lubricating.

Figs. 17-A, 17-B, 17-C, 17-D, and 17-E show the points to be lubricated for what might be called composite recorders. No recorder will have all the points shown in all these figures.

Use a good grade of medium weight oil and place only one or two drops on at a time. It is preferable to remove all excess oil.

The selector switches (on multiple-point recorders) should be kept clean and, under normal operating conditions, lubricated with a thin film of pure Vaseline. If the operating conditions are such that too frequent cleaning is required with a thin film of Vaseline on the contacts, a more generous supply of Vaseline should be used. If the operating conditions are such that too frequent cleaning is required even with a generous supply of Vaseline on the contacts, they should be immersed in a special oil obtained from Leeds & Northrup Company. Each selector switch requires approximately 1/3 pint of oil.

Under normal operating conditions the following cleaning and lubricating schedule should be used.

A. Every Month

(1) Oil all parts indicated by * in Figs. 17-A to 17-E inclusive.

(2) Clean the pen carriage or print wheel carriage shaft and the print wheel carriage guide rod. This may be done as follows: Place a small quantity of oil on a cloth, and rub the shaft or rod until clean. On instruments provided with a pen carriage, leave a film of oil on the shaft or rod for lubricating purposes.

(3) Place two or three drops of oil on the pinion and gears at 24, Fig. 25, and also on the smaller gears at this point which drive split gears 65, Fig. 25.

B. Every Two Months

(1) Oil all parts indicated by ◑ in Figs. 17-A to 17-E inclusive.

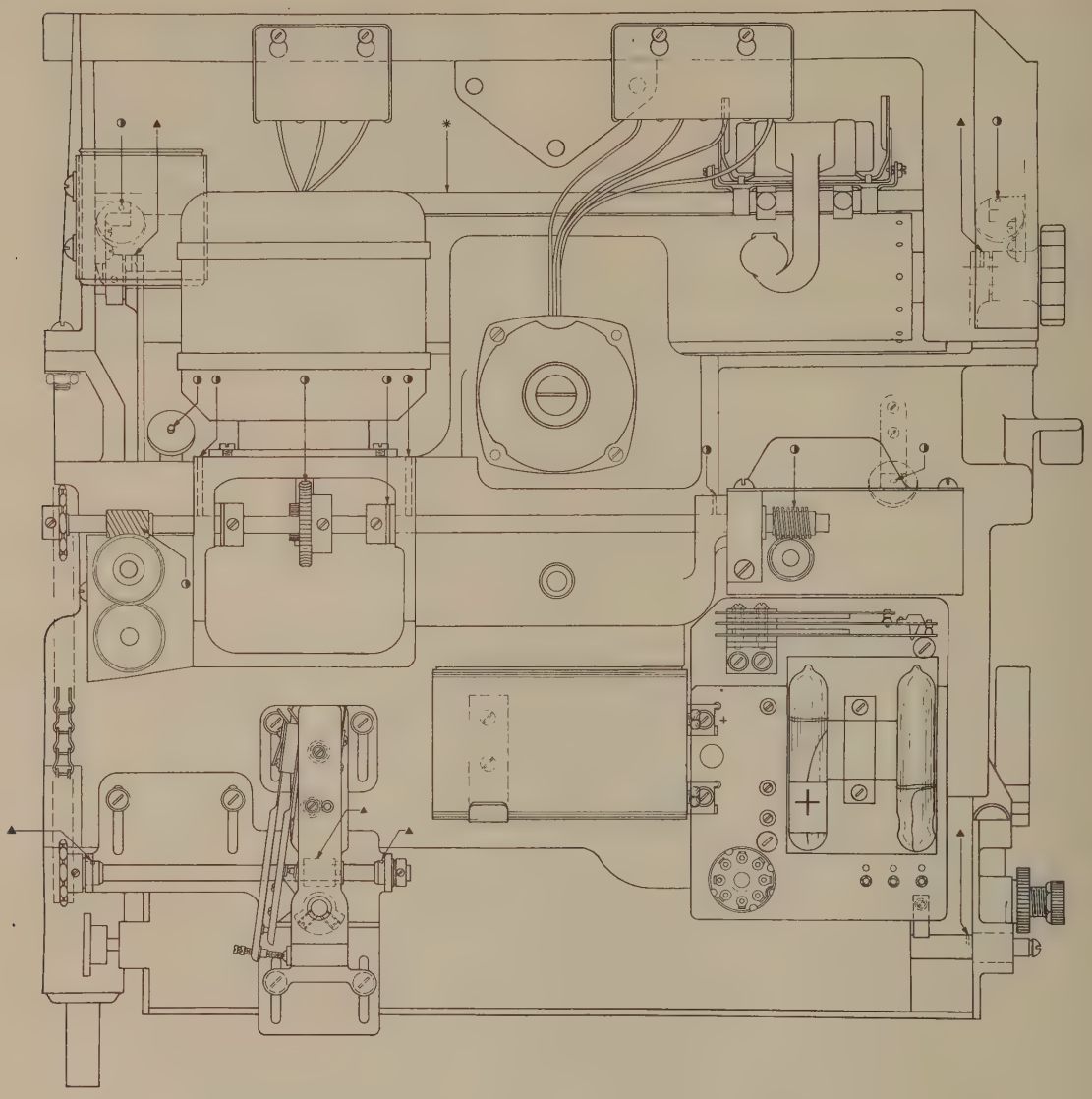

Fig. 17A—Lubricating chart for mechanism on main hinged casting.

(2) Clean slidewires as follows:

(a) Main Slidewire (measuring circuit) and Control Slidewire

Clean the slidewires by rubbing a cloth moistened with benzine over the contacting surface of the slidewires. If the recorder is in a location where the use of benzine is prohibited, carbon tetrachloride may be used sparingly. Do not apply Vaseline or any other lubricant to these slidewires. For certain applications it may be desirable to clean the slidewires more often than every two months.

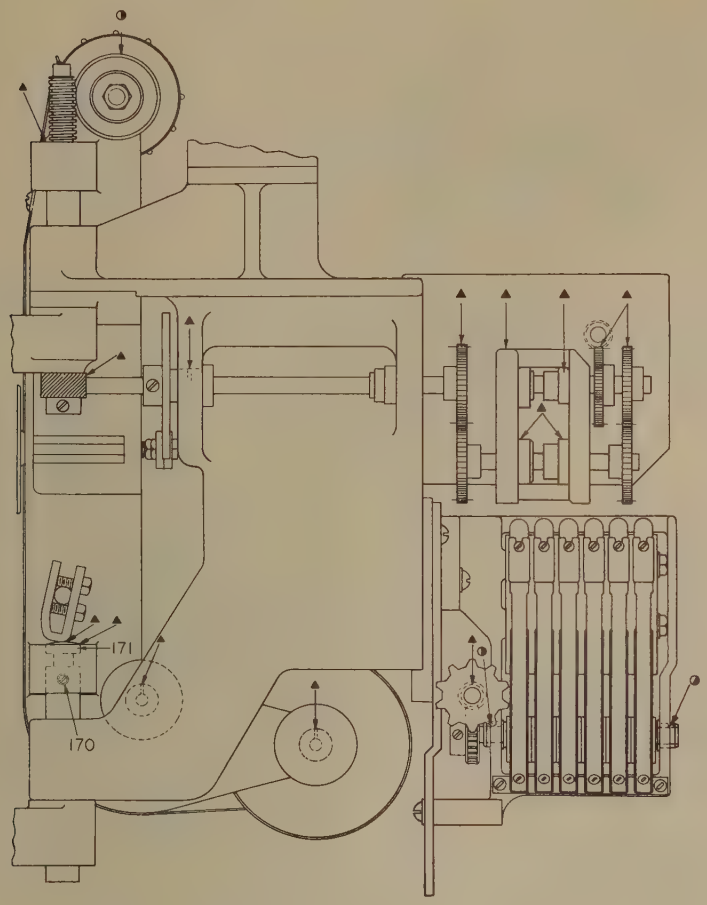

Fig. 17B—Lubricating chart for main hinged casting (viewed from hinged end).

(b) All Other Slidewires

Place a small quantity of pure Vaseline on a cloth and work the Vaseline into the cloth so as to have no excess Vaseline. Then rub the cloth over the contacting surface of the slidewire, being careful to wipe off any excess Vaseline from the slidewire. It may be necessary to repeat this procedure several times to properly clean the slidewire. If the Vaseline fails to clean properly it may be necessary to use a good grade of benzine, followed by a cleaning with Vaseline. If the recorder is in a location where the use of benzine is prohibited, carbon tetrachloride may be used sparingly, followed by a cleaning with Vaseline. For certain applications it may be desirable to clean the slidewire more frequently.

C. Every Four Months

In addition to the items listed under A and B above, oil all parts indicated by ▲ in Figs. 17-A to 17-E inclusive.

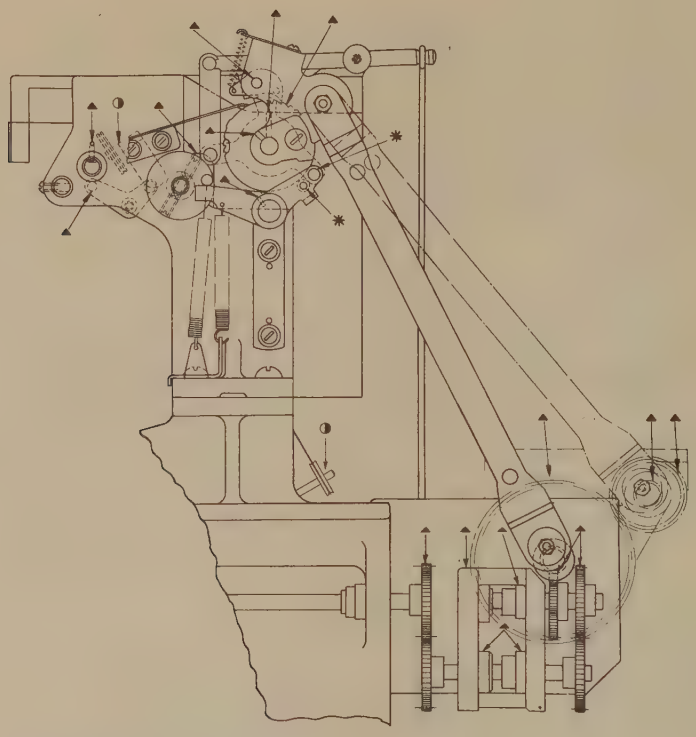

Fig. 17C—Lubricating chart for multipoint mechanism on main hinged casting (viewed from hinged end).

D. Every Eight Months

In addition to the items listed in A, B, and C above, the contacts on the commutator and those used with disks for control or signal work should be cleaned with a cloth into which a little Vaseline has been rubbed.

21. CARE OF MOTOR BEARINGS

A. Lubrication

Synchronous motors (capacitor type) and two-phase balancing motors are equipped with end sealed type ball bearings properly packed with grease before leaving the factory. They should, therefore, require no attention for at least a year, or possibly two years. It is recommended that no lubricant be added to the bearings and that the bearings be replaced with new ones when they become objectionably noisy.

B. Install Chart Drive Motor Bearings

Remove the motor leads from the terminal block and the four screws from the motor base and lift the motor clear of the gear box. Remove the gear from the end of the motor shaft.

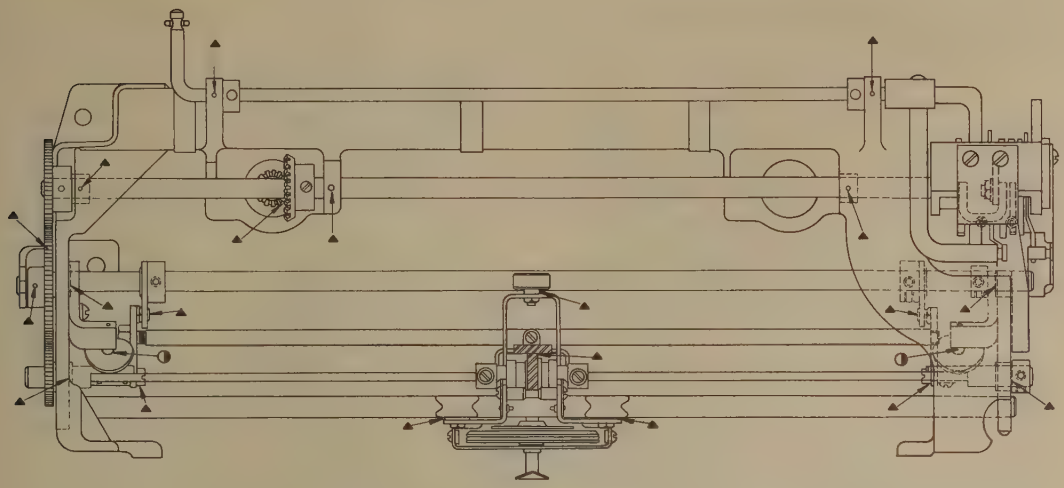

Fig. 17D—Lubricating chart for multipoint mechanism (viewed from the top).

Remove the four screws or through bolts which hold the top end cover in place. Then tap the top end cover to loosen it and remove the cover from the motor. In doing this be careful to note the arrangement of any thrust plate and washers on this end of the motor shaft. Lift the motor rotor out of the motor frame, being careful to note the arrangement of any washers on this end of the motor shaft.

Use a bearing puller, or other convenient method, to remove the bearings from the shaft. Place the new bearings (order the proper bearing from Parts Catalog P-ND46(1) for the motor being used) on the shaft. In some instances one side of the bearings is open. In such cases this open side of the bearings should, in each case, face toward the end of the shaft. Be sure to push the new bearings tightly against shoulders on the shaft. In doing this, be sure to place pressure only on the inner ball race of the bearing (this race is lower than the outer race).

Before fitting the rotor in place in the end covers, place a small amount of grease (Leeds & Northrup Part No. 90-1-0-3) in the grease well in each end cover.

Replace any spacers on the lower end of the shaft and insert the rotor in the stator. Then replace the washers, etc., on the upper end of the shaft and replace the top end cover. Adjust the top end cover and replace the four screws or through bolts to hold the cover in place. Replace the gear on the motor shaft and fasten it in place with the pin.

Replace the motor on the gear box, align the worm and worm gear and see that they do not bind, then replace and tighten the four screws in the base plate to hold the motor in place. Connect the motor leads to the terminal block.

C. Install Balancing Motor Bearings

Disconnect the motor leads from the terminal block. Then remove the nuts on the ends of the two bolts 23, Fig. 3, and remove the motor from the recorder. Remove the gear from the end of the motor shaft. This gear is fastened with a hex nut.

Remove the two screws or through bolts which hold the top end cover in place. Then tap the top end cover to loosen it and remove the cover from the motor. In doing this be careful to note the arrangement of any thrust plate and washers on this end of the motor shaft. Lift the motor rotor out of the motor frame, being careful to note the arrangement of any washers on this end of the motor shaft.

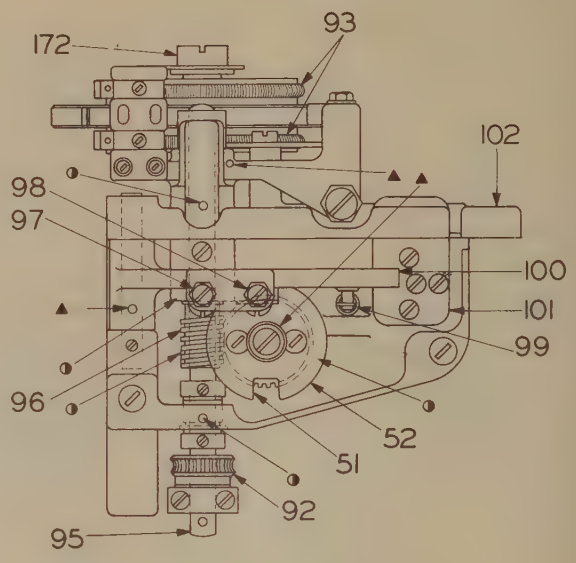

Fig. 17E—Lubricating chart and details of automatic current adjuster (viewed from the top).

Use a bearing puller, or other convenient method, to remove the bearings from the shaft. Place the new bearings (Leeds & Northrup Part No. 008052, packed with grease) on the shaft. Be sure to push the new bearings tightly against shoulders on the shaft. In doing this, be sure to place pressure only on the inner ball race of the bearing (this race is lower than the outer race).

Replace any washers and spacers on the upper end of the rotor, insert the rotor in the stator and fit the top end cover in place. Then replace any washers and spacers on the lower end of the shaft and fit the bottom end cover in place. This cover must go on in a given way, in order to be able to mount the motor in the recorder. To do this, hold the motor with the nameplate facing up. Then fit the bottom end cover on so that the holes for the two screws or through bolts are in the upper right hand corner and the lower left hand corner when facing the bottom of the motor. Replace the two screws or through bolts to hold the covers in place.

Replace the gear on motor shaft and tighten the nut to hold the gear on the shaft. Fit the motor approximately in position in the recorder but do not mesh the gear on the motor shaft with the gears at 24, Fig. 25. First, displace the two sections of the large split gear 65, Fig. 25, a distance of three teeth in the direction to place tension on the springs on this gear. Hold the two sections of gear 65 displaced as above and mesh the gear on the end of the motor shaft with the gears at 24, Fig. 25. Be sure these gears do not bind. Then tighten the two bolts 23, Fig. 3, to hold the motor in place. Reconnect the motor leads to the terminal block.

22. CHECK AND ADJUST CURRENT OF POTENTIOMETER CIRCUIT

A. With Automatic Current Adjuster

Although the automatic current adjuster takes care of adjusting this current approximately every 48 minutes while the recorder is operating, the current can be checked at any time, while it is operating, semi-automatically as follows: While the recorder is operating, turn knob 28, Fig. 1, in the direction indicated by the arrow, as far as it will go and hold it in this position. If the current is properly adjusted, the pen or print wheel carriage will not move. If this condition does not exist, hold knob 28 as directed above until this condition is obtained. Then release knob 28. Should the pen or print wheel carriage travel to either end of the scale before it comes to rest, release knob 28, wait a few seconds and then again proceed as indicated above.

If the current cannot be balanced as directed above, the dry cell should be replaced by a new one. Then adjust the current as directed in Section 13-A.

B. With Semi-Automatic Current Adjuster

When the recorder is equipped with a semi-automatic current adjuster this adjustment should be made at least once a day as follows: While the recorder is operating, turn knob 28, Fig. 1, in the direction indicated by the arrow, as far as it will go and hold it in this position. If the current is properly adjusted, the pen or print wheel carriage will not move. If this condition does not exist, hold knob 28 as directed above until this condition is obtained. Then release knob 28. Should the pen or print wheel carriage travel to either end of the scale before it comes to rest, release knob 28, wait a few seconds and then again proceed as indicated above.

If the current cannot be balanced as directed above, the dry cell should be replaced by a new one. Then adjust the current as directed in Section 13-B.

23. REPLACE DRY CELL

A. For Potentiometer Type Measuring Circuit

When the red signal appears at the battery tell tale indicator 211, Fig. 1, the dry cell should be replaced by a new one. After the new cell is installed, adjust the current in the potentiometer circuit as directed in Section 13-A for an automatic current adjuster or Section 13-B for a semi-automatic current adjuster.

B. For Resistance Type Measuring Circuit

When an a-c bridge is used for this type circuit, a dry cell will, of course, not be used. However when a d-c bridge is used, a dry cell will be used. In this case a small d-c voltmeter is mounted above the left end

of the indicating scale. When the dry cell is fresh, the meter pointer will be well over to the right (on the white section of the scale). When the pointer drops to the red section of the scale, the dry cell should be replaced with a fresh one.

PART III

SERVICING UNDER UNUSUAL CONDITIONS

24. CLEAN THE PEN

If the pen stops inking while it still contains ink, moisten a finger and draw it across the pen point. If this procedure fails, remove the pen from the carriage. Insert one of the fine wires (supplied for this purpose) in the pen point and push it through the point to clean out any particle clogging it.

If the ink still does not flow, remove the clogged pen from the clip and install a new pen as directed in Section 7-A. Place the clogged pen in alcohol or boiling water for a short time. Remove the pen from the solution and insert a cleaning wire as previously directed. Then fill the pen with alcohol or warm water and blow the liquid out through the pen point. Allow the pen to thoroughly dry before using.

25. INSTALL NEW PEN

If it is found necessary to replace the pen, remove the clip and pen as a unit from the recorder and remove the pen from the clip. Install the new pen as directed in Section 7-A.

26. ADJUST PEN CARRIAGE

If the pen carriage becomes loose on the drive cord, it may get out of alignment. To check this condition, stop the recorder and rotate the split gear 65, Fig. 25, to bring the pen to the low end of the scale (until the gear is against the low end stop). Under this condition, the pen point should be on the end line at the low end of the paper chart.

If this condition does not exist, loosen the two screws 221, Fig. 8, to release the pen carriage from the drive cord. Hold gear 65 against the low end stop as directed above and move the pen carriage until the pen point is on the end line at the low end of the paper chart. Tighten the two screws 221 to hold the pen carriage in place.

27. CLEAN THE TYPE ON PRINT WHEEL

The type on the print wheel may in time become slightly clogged with foreign particles and print blurred characters. When this occurs, the type should be cleaned. To do this, stop the recorder and swing out the operating mechanism assembly. Moisten a portion of a cloth with carbon tetrachloride or benzine and clean type on the print wheel with this moistened cloth. To rotate the print wheel while cleaning, rotate gear 53, Fig. 13, in a counterclockwise direction.

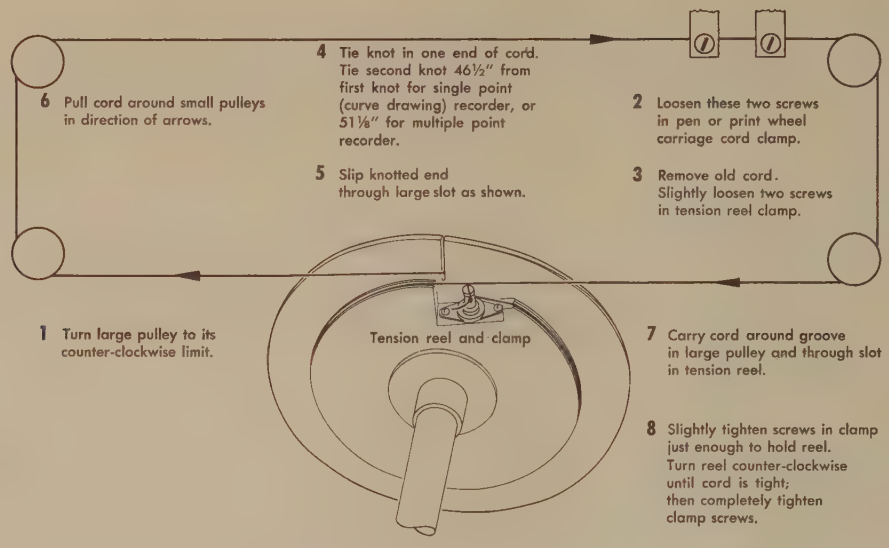
4 Tie knot in one end of cord. Tie second knot 46½" from first knot for single point (curve drawing) recorder, or 51⅛" for multiple point recorder.
6 Pull cord around small pulleys in direction of arrows.
2 Loosen these two screws in pen or print wheel carriage cord clamp.
5 Slip knotted end through large slot as shown.
3 Remove old cord. Slightly loosen two screws in tension reel clamp.
1 Turn large pulley to its counter-clockwise limit.
Tension reel and clamp
7 Carry cord around groove in large pulley and through slot in tension reel.
8 Slightly tighten screws in clamp just enough to hold reel. Turn reel counter-clockwise until cord is tight; then completely tighten clamp screws.

Fig. 18—Installing drive cord for pen or print wheel carriage.

28. ADJUST PRINT WHEEL CARRIAGE AND MECHANISM

If the print wheel carriage becomes loose on the drive cord it may get out of alignment. To check this condition, stop the recorder and rotate the split gear 65, Fig. 25, to bring the print wheel to the low end of the scale (until the gear is against the low end stop). Under this condition, the indicator on the print wheel carriage should be at the end line at the low end of the indicating scale.

If this condition does not exist, loosen the screw 221-B, Fig. 9, and similar screw at opposite side, to release the print wheel carriage from the drive cord. Hold split gear 65, Fig. 25, against the low end stop as directed above and move the print wheel carriage until the indicator on the carriage is located as above. Tighten the two screws to hold the print wheel carriage in place.

Start the recorder mechanism, allow it to operate through one point and then stop it. Slide the print wheel carriage on the shaft to determine whether it binds on the rectangular shaft 150, Fig. 27. If there is a slight binding on this shaft, loosen the setscrews in gear 144, Fig. 27, and rotate the shaft 150, Fig. 27, a very slight amount in a clockwise direction (when facing the shaft from the gear end) to clear the hole in the print wheel carriage. Be sure gear 53 is not turned while making this adjustment. Then tighten the setscrews in gear 144 and recheck for binding. Continue this procedure until there is no binding of shaft 150.

Operate the mechanism to its printing position. There must be clearance of .015 to .030 inches between the crank collar stud 139 and arm 137 on Fig. 26 to insure that the full printing pressure is on the chart and not

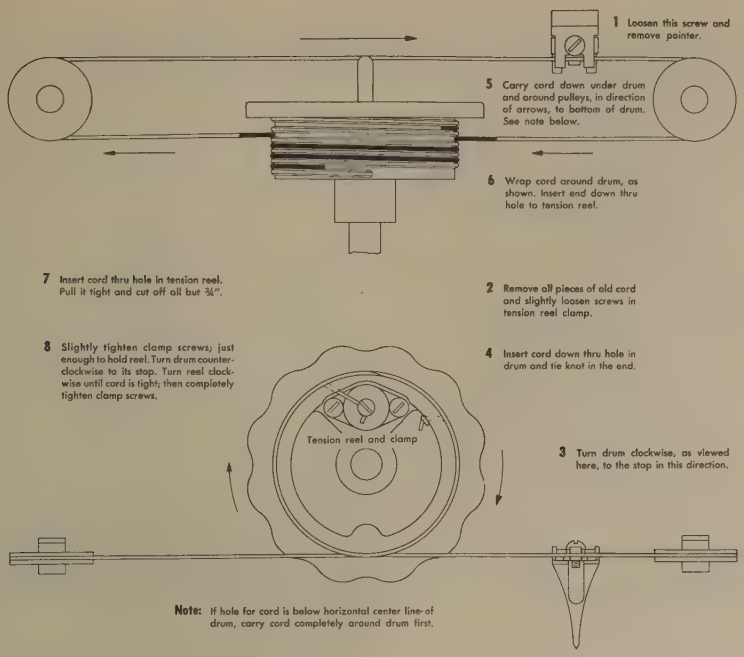
1 Loosen this screw and remove pointer.
5 Carry cord down under drum and around pulleys, in direction of arrows, to bottom of drum. See note below.
6 Wrap cord around drum, as shown. Insert end down thru hole to tension reel.
7 Insert cord thru hole in tension reel. Pull it tight and cut off all but ¾".
2 Remove all pieces of old cord and slightly loosen screws in tension reel clamp.
8 Slightly tighten clamp screws; just enough to hold reel. Turn drum counter-clockwise to its stop. Turn reel clockwise until cord is tight; then completely tighten clamp screws.
4 Insert cord down thru hole in drum and tie knot in the end.
Tension reel and clamp
3 Turn drum clockwise, as viewed here, to the stop in this direction.
Note: If hole for cord is below horizontal center line of drum, carry cord completely around drum first.

Fig. 19—Installing drive cord for contact setter.

on arm 137. If a clearance of .015 inches does not exist in the printing position, loosen the screw in cam 135 and slide the cam up slightly in its slotted hole to reduce the pressure on roller 136, thus lowering the other side of 137 to permit the necessary clearance. If the clearance is greater than 0.030 inches in the printing position, slide cam 135 down slightly in its slot. Check this clearance with the print wheel unit in printing position at both ends of its travel to make sure the limits of clearance are maintained all the way across the chart. Also check the clearnace between tab 73 on the arm and the standardizing interlock 72 when the instrument is being standardized. This clearance must be approximately .010" and if excessive will allow printing during standardization. Bend tab 73 to obtain the require clearance.

If, on the multicolor print wheel unit, the point number and pad color combination is to be changed, loosen the setscrews in gear 146, Fig. 27, and rotate the pad wheel until the desired combination is obtained. Then tighten the setscrews.

29. INSTALL DRIVE CORD

A. For Pen or Print Wheel Carriage

In order to install a drive cord, for the pen or print wheel, swing out the chart assembly to make the drive pulley accessible. Then proceed as indicated in Fig. 18.

After completing the installation of the cord, adjust the pen or print wheel carriage as indicated in Section 26 or Section 28.

B. For Contact Setter

To replace the cord on a contact setter, swing out both castings together to make the cord available and then proceed as indicated in Fig. 19.

After the clamp screws have been tightened to hold the reel in place, again turn the drum in a clockwise direction to its stop. Replace the pointer on the cord. Hold the drum against its stop and adjust the pointer until it lines up with the end line at the low end of the scale. Then tighten its screw to hold it in place.

30. REMOVE MAIN SLIDEWIRE

To remove the main slidewire 66, Fig. 25, from the shaft, back screw 67, Fig. 25, out several turns. Then place a hard flat object, about six inches in length, across the front of the slidewire assembly, resting the plate against the head of the screw. Next, duplicating the action of a wheel puller, place the palm of each hand against the flat plate and the fingers behind the slidewire assembly and squeeze to loosen the slidewire from the tapered shaft. Then remove the screw and washer at 67 and slide the entire slidewire assembly from the end of the shaft. For access to slidewire connecting pins, remove the electrostatic shield and insulator from the rear of the assembly.

To replace the main slidewire, fit the assembly over the end of the shaft with arm 226, Fig. 25, fitted on pin 227, Fig. 25, and with the pin in hub at 67, Fig. 25, fitted properly over the flat section on the shaft. Replace the washer and screw at 67, Fig. 25, and carefully tighten the screw.

31. INSTALL NEW CONTACTS ON MAIN SLIDEWIRE

To install new contacts on the main slidewire, proceed as follows:

All references are to Fig. 20 unless otherwise stated. The procedures identified with an * need not necessarily be complied with if the base cover has been cut away to permit access to the screws in the contact mounting block.

Rotate the cover on the main slidewire a slight amount in a counterclockwise direction and remove it from the slidewire.

*Back out screw 180 to release the pressure on arm 182.

*Remove the two screws 181 and remove arm 182 (complete with contacts 183).

Remove the four screws 184 and remove the small block and attached contacts.

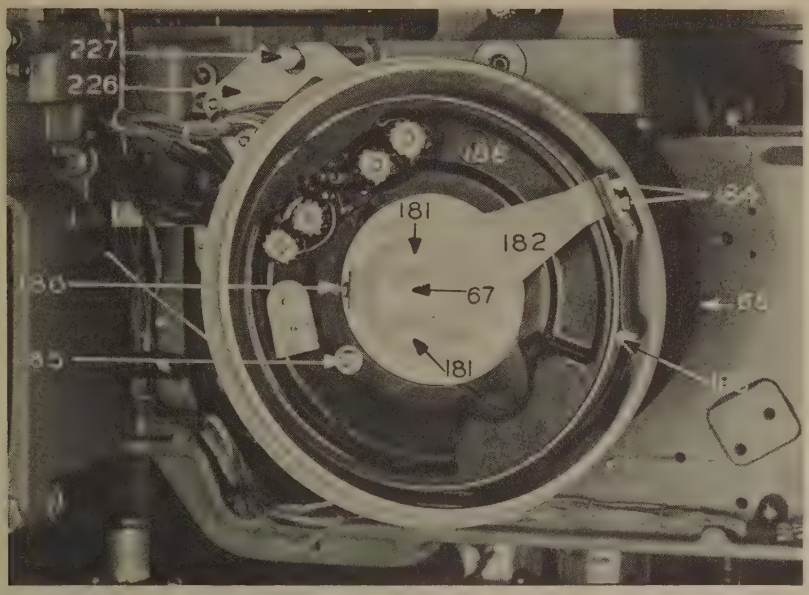

Fig. 20—Details of the main slidewire and contact (cover removed).

Place the new contacts and block in position on arm 182 and fasten them in place with the four screws.

*Fit arm 182 in place, with contacts 183 on the slidewire, and replace and tighten screws 181 just enough to hold the arm in place.

Adjust screw 180 and individual contact fingers until the pressure of each contact is between 2 and 4 ounces, and then finally tighten screws 181 to hold this adjustment. Also tighten locknut on screw 180 to hold this screw in place.

Check the recorder calibration and make corrective adjustments, if necessary, as explained in Section 33.

Replace the cover on the slidewire.

32. AMPLIFIER

A. General Information

It is recommended that a spare set of electron tubes be stocked to aid in servicing the amplifier. When insensitivity is noticed, even with the sensitivity rheostat in its highest position, the tubes should be checked. It is suggested that any weak tubes be replaced with new ones. These tubes may be purchased locally; however, it is preferable to order tubes, which have had a more complete quality check, from Leeds & Northrup Company.

If the recorder should perform improperly, and new tubes do not remedy the trouble, remove the amplifier and substitute another amplifier.

To remove the amplifier, remove plugs 13 and 14, Fig. 10. Also remove screws 15 and loosen screws 18 and 19. Then slide the amplifier from the recorder case.

B. Testing and Servicing

More detailed data on the amplifiers, including testing and servicing of these units, is available in the following publications:

(1) Testing And Servicing Standard Level Amplifiers, (L&N® Part No. 77-28-0-8).

(2) Testing And Servicing Low Level pH Type Amplifiers, (L&N Part No. 77-28-0-13).

These can be obtained from Leeds & Northrup Company.

A servicing kit, 9905 Speedomax G Servicing Equipment, for use in testing and servicing the amplifiers, may be ordered from Leeds & Northrup Company. Directions (L&N Part No. 77-32-0-3), describing the use of this kit, are included with it.

33. CALIBRATION

A. Preliminary

To check the recorder calibration proceed as follows:

Turn split gear 65, Fig. 25, to move the pen or print wheel carriage toward the low end of the scale until the stop is reached in this direction. Then close and latch the chart assembly. Under these conditions the pen or print wheel should register at the low end line of the paper chart. If this condition does not exist, loosen the two screws holding the pen or print wheel carriage to the drive cord and move the carriage until the above condition does exist. Then tighten the two screws to hold the carriage in place.

After the above adjustment is completed, keep the pen or print wheel on the last line at the low end of the paper chart. When in this position the indicator on the carriage should be in line with the last line on the indicating scale. If this condition does not exist, loosen the screws 223, Fig. 1, and slide the scale a sufficient amount to have the last line at the low end line up with the indicator on the carriage.

B. Potentiometer Type Circuit

Adjust the current in the recorder measuring circuit as described in Section 22-A.

If the recorder is used for straight millivolt measurement and no automatic reference junction compensation is employed, proceed as follows:

(1) Connect the E.M.F. terminals of a portable potentiometer to the recorder E.M.F. terminals, after disconnecting any other external source of emf.

(2) Adjust the portable potentiometer to cause the pen to travel to the left end of the recorder scale. Then increase the applied emf to, but not above, a value near the middle of the recorder scale and note the reading. Now adjust the portable potentiometer to cause the pen to travel to the right end of the scale. Then decrease the applied emf to, but not below, the same value as was used just previously, and note the reading. (If there is an appreciable distance between the two recorder readings, the sensitivity rheostat on the amplifier chassis should be adjusted by turning shaft 16, Fig. 10, in a clockwise direction to decrease the width of this insensitive band.) The recorder reading should check with the applied emf within the accuracy of the recorder. If the recorder reading is not correct, remove the cover from the main slidewire and loosen screw 185, Fig. 20 (and similar screw hidden by arm 182) a slight amount and adjust the slidewire disk until the scale reading is correct. Then tighten the two screws to hold the disk in place and replace the cover.

If the recorder is furnished with an automatic reference junction compensator, proceed as follows:

(1) Measure the temperature at the reference junction coil located on circuit panel 94, Fig. 3, by placing a mercury thermometer in the hole in the coil shown in Figs. 21 and 3.

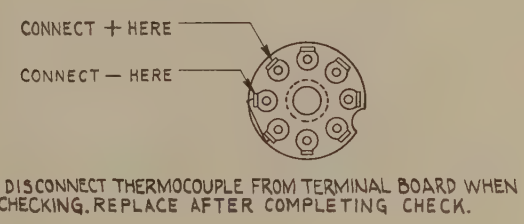
CONNECT + HERE
CONNECT — HERE
DISCONNECT THERMOCOUPLE FROM TERMINAL BOARD WHEN CHECKING. REPLACE AFTER COMPLETING CHECK.

Fig. 21—Connections of potentiometer to reference junction coil when checking recorder calibration.

(2) Determine the millivoltage equivalent to a scale setting near the center of the pen travel and the millivoltage equivalent to the reference junction temperature (referring to the temperature conversion table, based on either 0 F or 0 C, for the type of thermocouple being used). The difference between these two values is the "effective" millivoltage.

(3) Connect the E.M.F. terminals of the portable potentiometer to the positions indicated in Fig. 21.

On multiple-point recorders with a remote reference junction thermocouple it will also be necessary to disconnect the reference thermocouple from terminals RJ(+) and RJ(-) and to jumper the TC(+) and TC(-) terminals on the terminal board corresponding to the switch point about to print. Prevent the switch advance mechanism from operating during these tests by removing the chart drive motor fuse.

(4) Adjust the potentiometer to cause the pen or print wheel carriage

pointer to travel to the left end of the scale. Increase the potentiometer emf to, but not above, the "effective" millivoltage and note the temperature indicated on the recorder scale. Now adjust the potentiometer to cause the recorder pointer, this time, to travel to the right end of the scale. Decrease the potentiometer to, but not below, the "effective" millivoltage and note the resulting temperature indication. The two temperature indications obtained should be at, or an equal distance to either side of the major temperature division selected for this calibration check. If the recorder balances as described the calibration is correct. If the average temperature indication obtained is not within the measuring accuracy of the recorder, remove the cover from the main slidewire and loosen screw 185, Fig. 20 (and similar screw hidden by arm 182) a slight amount and adjust the slidewire disk until the scale reading is correct. Then tighten the two screws to hold the disk in place and replace the cover.

C. Resistance Type Circuit

A check coil is supplied with all resistance type recorders. The data on this coil indicates the value at which the recorder pen should balance when the check coil is connected into the circuit.

If the recorder does not check at the given value, adjust the slidewire disk as indicated in the preceding section.

34. ADJUST PRINTING AND SWITCH ADVANCE MECHANISM IN PROPER RELATION TO CURRENT ADJUSTER MECHANISM

Stop the recorder when the rider on timing cam 52, Fig. 17-E, is down in slot 51, Fig. 17-E, and the rider at 97 is centered on its cam. The current adjuster is then in the operating position. With the current adjuster in this position, arm 70, Fig. 22, should be down, in the direction indicated by arrow W, far enough to move cam 71, Fig. 22, around so that arm 72 is opposite arm 73 and arm 74 is under the two pawls at 75. At the same time cam 76, Fig. 22, should be around so that the notch 77 is opposite pin 78.

If it is necessary to adjust cam 71, loosen the setscrew in collar 79 and adjust arm 80, Fig. 22, until arm 72 is opposite arm 73 so as to hold arm 73 out. Then tighten the setscrew in collar 79 to hold arm 80 in position.

If it is necessary to adjust cam 76, use a screwdriver or similar

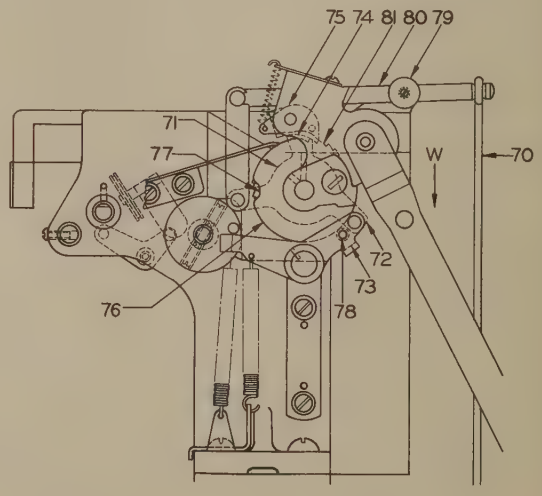

Fig. 22—Details of part of multipoint mechanism (viewed from hinged end).

tool, and carefully push on the teeth of ratchet 81 until slot 77 is opposite pin 78.

It may be observed that pin 72 is similar to pin 78. However, these pins are installed differently in that pin 72 is free to rotate while pin 78 is securely fastened. This is done intentionally to give best operating conditions.

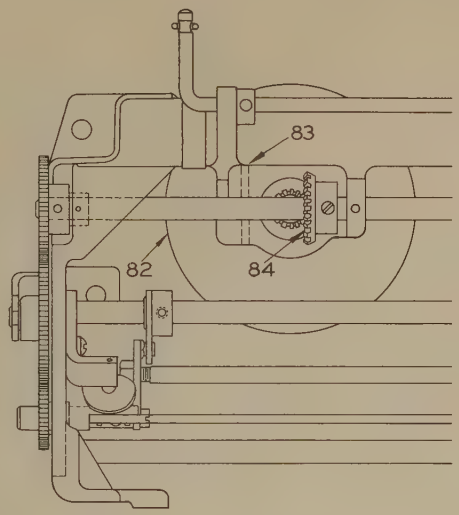

Fig. 23—Details at multipoint switch (viewed from the top).

35. ADJUST SELECTOR SWITCH IN PROPER RELATION TO PRINT WHEEL

Stop the recorder with point #1 showing at the indicator on the front of the print wheel. Then turn the metal cover 82, Fig. 23, over the selector switch and remove the cover. Note the position of the contacts nearest the edge of the switch (on the long arm). These contacts should be on the switch segments which are located at the figure 1 cut into the edge of the switch molding.

If this condition does not exist, loosen the clamping screw 83, Fig. 23, in the casting, a sufficient amount to permit the entire switch to be lowered enough to disengage the gears at 84, Fig. 23. Turn the contacts manually until the outer contacts are located as indicated above. Then push the entire switch up so as to mesh the gears at 84, Fig. 23.

After the gears are meshed at 84, start the recorder and allow it to advance one point on the switch. Then recheck the position of the contacts. If they are slightly out of position, turn the switch body a sufficient amount to bring the segments into the proper position. Then tighten the clamping screw 83, Fig. 23, and replace the metal cover over the switch.

Make certain the carriage rolls easily over the guide rails. During this check observe that shaft 150, Fig. 27, does not come in contact with the sides of the oblong hole through the carriage. The only time shaft 150 should touch the oblong hole is when the shaft initiates the advance of the print wheel to the next point. The print wheel should snap to each new print point with the result that the oblong hole will be free of the drive shaft during the measuring and printing cycle. If binding occurs, loosen the setscrews in gear 144, Fig. 27, and rotate rod 150 a slight amount so as to clear the oblong hole in the print wheel carriage. Then tighten the setscrews in gear 144 and carefully recheck the operation.

PART IV

OPERATION AND GENERAL FEATURES

36. OPERATION OF CONTACT SETTING DEVICE

The mechanism used to manually set the control or signal contacts at the desired point is shown in Figs. 11 and 12. To set these contacts, rotate dial 29, Fig. 11, (or the extension knob to this dial on the outside of the recorder case when such an extension is used) in the proper direction to move the red indicator 30, Fig. 11, to the value on the scale for which the instrument is to control or the point from which the signal lamps are to function.

When dial 29 is rotated to set the red indicator, it also rotates the gear train 33, 34, and 85, Figs. 11 and 12. Through this gear train, gear 86, Fig. 12, is rotated. Disk 87, Fig. 12, is part of gear 86 and ofcourse rotates with gear 86. The contact block 88, Fig. 12, is fastened to disk 87 and therefore the contacts which are mounted on this block rotate with disk 87.

In this way, when dial 29, Fig. 11, is rotated to set the red indicator at the desired value on the scale, the contacts are rotated to the proper position in respect to the disks 89 and 90, Fig. 12. These disks are rotated by the recorder balancing motor which in turn is governed by the conditions in the measuring circuit. Thus, a change in the measuring circuit causes disks 89 and 90 to rotate and the disks in turn operate the contacts, as positioned by the setting device.

The contacts are held in position by means of a friction clutch at 152, Fig. 12. The stationary part of this clutch is held by pin 153, Fig. 12.

37. OPERATION OF AUTOMATIC CURRENT ADJUSTER

The automatic current adjuster mechanism is driven by worm 91, Fig. 3, on the main shaft. This worm 91, through worm gear 92, Fig. 3, operates the mechanism located under cover 55, Fig. 3. A plan view of this complete mechanism is shown in Fig. 17-E with a view from the standard cell circuit rheostat end shown in Fig. 24. This same rheostat is also shown at 93, Fig. 25. The contacts which change the detector from the measuring circuit to the standard cell circuit are shown at 94, Fig. 3.

The main shaft, through worm 91 and worm gear 92, Fig. 3, rotates shaft 95, Fig. 17-E. This shaft in turn rotates worm 96, Fig. 17-E, and the operating cam under point 97. Worm 96 rotates disk 52, Fig. 17-E, in a clockwise direction as viewed in Fig. 17-E. A rider, under point 98, Fig. 17-E, is arranged to fit into slot 51, when disk 52 rotates to this position. A rider, under point 97, is arranged to operate on the cam under this same point. When the rider at 98 is centered over the slot 51, the cam at 97 is arranged to have the rider at this point drop to a low section

on the cam. This permits the rider at 98 to drop into slot 51. This dropping operation is caused by the spring 99, Fig. 17-E, attached to arm 100, Fig. 17-E.

When arm 100 drops, it carries extension 101, Fig. 17-E, down and along with this extension, arm 102, Fig. 17-E. Arm 102 is attached to arm 103, Fig. 24; which in turn swings the unit containing the slidewire 93 and disk 104, Fig. 24, over against the metal disk operated by the main slidewire shaft. At the same time, arm 102, Figs. 17-E and 24, operates the contacts at 94, Fig. 3, to disconnect the thermocouple and connect the standard cell to the circuit. The equipment stays in this position for several revolutions of the main shaft. If the potentiometer circuit current is not balanced, the balancing motor will function to rotate the main slidewire shaft. This rotates a metal disk which is in contact with disk 104, Fig. 24, and this disk in turn rotates rheostat 93 in the direction indicated by arrow X, Fig. 24, to balance this current.

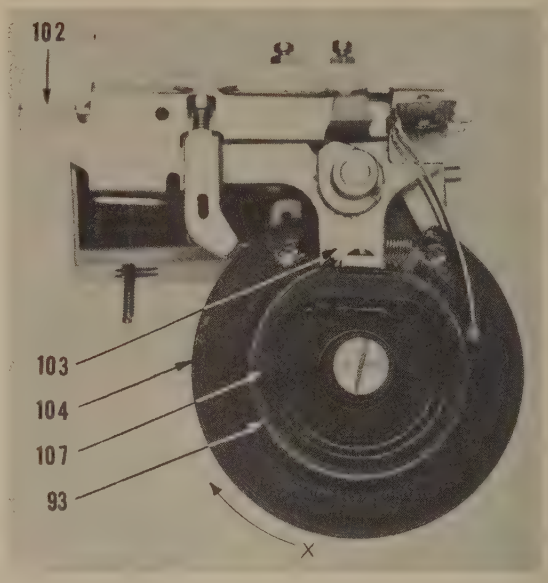

Fig. 24—Current adjusting rheostat with its operating disk, in a potentiometer measuring circuit.

At the end of the operation period, the cam at 97, Fig. 17-E, raises arm 100, Fig. 17-E. This permits the disk and rheostat unit to swing back into the normal position and at the same time arm 102, Fig. 17-E, moves up and allows the contacts 94, Fig. 3, to transfer the circuit connections from the standard cell to the thermocouple. In the meantime, disk 52, Fig. 17-E, has rotated far enough to be under the rider at 98, Fig. 17-E, which holds arm 100 up until the next period for adjusting the current.

As rheostat 93, Figs. 24 and 25, is rotated to adjust the current in the potentiometer circuit, it carries pin 107, Fig. 25, in a clockwise direction toward arm 108, Fig. 25. As pin 107 raises arm 108 this arm rotates arm 109, Fig. 25, which in turn operates the red signal to show at the opening in the indicator 211, Fig. 1.

Knob 28, Fig. 25, through an extension, operates on arm 102, Fig. 24, so as to move arm 102 down and thus adjust the current at any time while the recorder is operating.

38. OPERATION OF MULTIPLE-POINT MECHANISM

The multiple-point mechanism is shown in Figs. 26 and 27. The

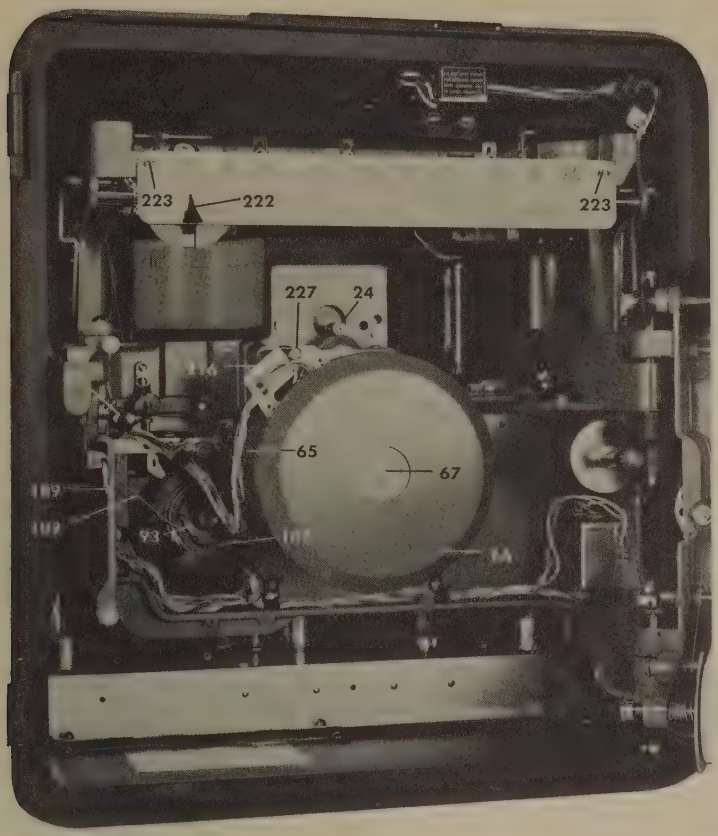

Fig. 25—View of mechanism on rear of main hinged casting.

mechanism is driven by the main shaft through the eccentric 129, Fig. 26, and the arm 130, Fig. 26. The upper end of arm 130 is attached to the rocker housing 131, Fig. 26, to which is attached the cam 76 and the three pawls located in a line at 75, Fig. 26. The pawl 75, shown in Fig. 26, operates separately on ratchet 81, Figs. 26 and 27. The other two pawls operate together, one on cam 132, Fig. 27, and the other on ratchet 134, Fig. 27. Each pawl is moved the equivalent of one tooth of ratchet 81 for each revolution of the eccentric 129, Fig. 26. In other words, ratchet 81 is rotated the distance of one tooth for each down stroke of arm 130, Fig. 26. Cams 132 and 76, Fig. 27, are attached to the same collar with ratchet 81 and are, therefore, rotated the same distance as ratchet 81 for each stroke of arm 130. Ratchet 134 is rotated only when a slot in cam 132 is under its pawl which permits the pawl of ratchet 134 to drop into place and rotate ratchet 134.

Spring 138, Fig. 26, pulls down on arm 137, which pivots at point 148, to keep pin 78 pressed against cam 76. Spring 147, Fig. 26, pulls down to keep pin 139 pressed against arm 137.

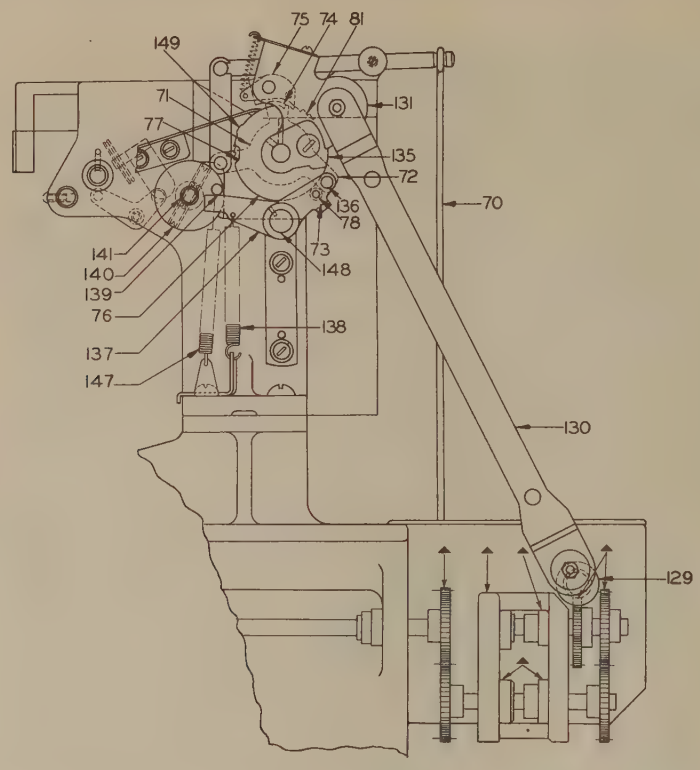

Fig. 26—Details of multipoint printing and switch advance mechanism (viewed from hinged end).

Ratchet 81 normally has 24 teeth, thus it makes a complete revolution for every 24 revolutions of the main cam shaft. During each revolution of ratchet 81, a slot 77, Fig. 26, of cam 76 is opposite pin 78, Fig. 26. When pin 78 drops into slot 77, spring 138 pulls arm 137, Fig. 26, down, thus allowing spring 147 to pull pin 139, Fig. 26, down. This action rotates collar 140, Figs. 26 and 27, a slight amount in a clockwise direction (viewed as in Fig. 26) and in turn shaft 141, Figs. 26 and 27. Forked arms 303, Fig. 27, attached to shaft 141, then raise levers 304 which in turn raise shaft 305. When shaft 305 is raised, as above, it rocks the print wheel carriage 148, Fig. 27, so as to move the print wheel down on the chart and print. On the next stroke of arm 130, Fig. 26, cam 76 operates against pin 136, Fig. 26. This action pushes pin 78 out of slot 77 and moves arm 137 up to the normal position which in turn restores pin 139 and, through shaft 141, the print wheel carriage to the normal position.

Just before slot 77 reaches pin 78, the hump 149, Fig. 26, on cam 76, reaches pin 78. This action pushes down on pin 78, which in turn pushes arm 137 up and hence pin 139 up. This action rotates shaft 141 a slight amount in a counterclockwise direction (viewed as in Fig. 26) and through forked arms 303, levers 304 and shaft 305, Fig. 27, rocks the print wheel carriage up against the ink pad so as to ink the character which is in the up position.

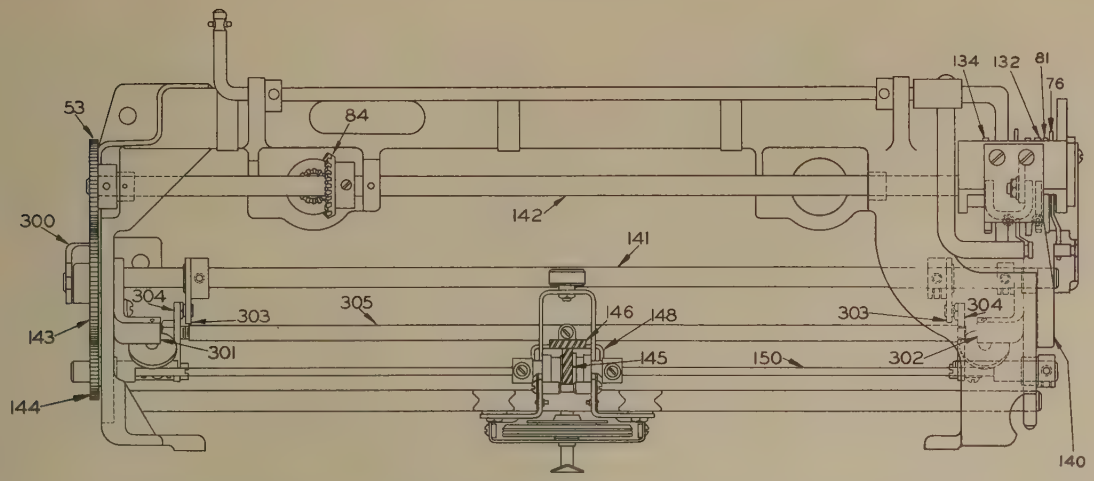

Fig. 27—Details of multipoint printing and switch advance mechanism (viewed from the top).

After pin 78 has been pushed out of slot 77 of cam 76, a notch in ratchet 132, Fig. 27, is under its pawl which drops in place. This action allows the pawl over ratchet 134, Fig. 27, to drop onto this ratchet. Thus, as arm 130 moves down, ratchet 134 is rotated. This ratchet is attached to shaft 142, Fig. 27, and rotates this shaft. This action rotates the bevel gears at 84, Fig. 27, which in turn rotate the selector switch to the next point. At the same time, shaft 142 rotates gear 53, Fig. 27, which rotates the idler gear 143 and gear 144, Fig. 27. Gear 144 is fastened to shaft 150, Fig. 27, which in turn rotates the spiral gears at 145 to move the print wheel to the next point. If the recorder is a multicolor instrument, this last movement also rotates spiral gear 146 to move the pad wheel to the next point.

The function of cam 71, Fig. 26, is to prevent the mechanism from printing and from advancing the selector switch and print wheel when the automatic current adjuster is in the operating position. When the automatic current adjuster is in the operating position, arm 70, Fig. 26, moves down and, through the linkage, cam 71, Fig. 26, rotates so that arm 74 prevents the pawls over ratchets 132 and 134, Fig. 27, from dropping and arm 72, Fig. 26, is opposite arm 73, Fig. 26, and prevents pin 78 from dropping into slot 77. When the current adjuster is returned to the normal position, cam 71, Fig. 26, is restored to the normal position. The next time that slot 77 reaches pin 78 the point which was delayed will be printed and the mechanism will then be advanced to the next point in the manner described above.

39. ADJUSTMENT OF CONTROL DISKS AND CONTACTS (EXPOSED TYPE)

In order to remove the entire control disk assembly, first remove the main slidewire as indicated in Section 30, and loosen setscrews 151, Fig. 12.

Then slip sleeve 155, Fig. 12, from the shaft along with disks 89 and 90, the spacers between the disks and also knurled nut 154, as a unit. In removing this assembly, be careful not to damage the contacts or flippers and note which setscrew was in the spot in the shaft. In replacing the unit, be sure and spot the same setscrew.

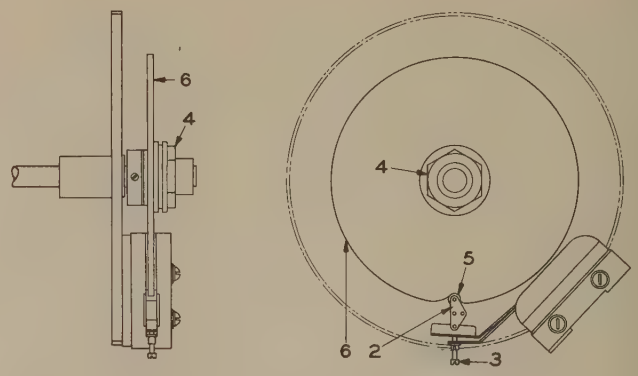

Fig. 28—Details of enclosed type control contacts and disk.

To rotate one disk in respect to the other, loosen screw 156, Fig. 12, a slight amount. Then rotate each disk the desired amount on either side of the control point and tighten screw 156 to hold the disks together.

40. ADJUSTMENT OF CONTROL DISKS AND CONTACTS (ENCLOSED TYPE)

A standard arrangement of an enclosed type contact is shown in Fig. 28. Switch-over action should occur when the control flipper is midway on the slope of the notch 5 in the control disk and the red and black indicators are set as described in Section 15.

To position disk 6, Fig. 28, to obtain this condition, loosen nut 4 and rotate the disk. To have switching action occur when the roller is midway on the slope of the notch, adjust screw 3. When properly adjusted, discernible overtravel before the roller engages the normal circumference of the disk or the bottom of the notch, should be apparent after switch action. At the bottom of the notch the roller should be just touching or have a maximum clearance of 1/32 inch. Do not make any adjustments by bending the contact actuating arm. Additional adjustment may be obtained by making use of the play in the contact assembly mounting holes.

41. GENERAL DESCRIPTION OF MEASURING CIRCUIT

A. Potentiometer Type

The measuring circuit of this type recorder is fundamentally a potentiometer, with a filtering and damping circuit and amplifier interposed between the thermocouple and the measuring circuit. The d-c off-balance between the thermocouple and the measuring circuit is passed through a filter to eliminate any a-c pick-up in the thermocouple leads (which do not have to be twisted, shielded or grounded) and is fed through a synchronous vibrator type converter and input transformer. The output of this transformer is applied to the grid of the first tube in the amplifier in the form of an a-c signal. This signal is then passed through three stages of

amplification to a power tube which in turn controls a 2-phase motor that drives the measuring circuit slidewire. One phase of this motor is connected across the line and the second phase, or the control winding, is energized by the amplifier. The phase relationship between the two windings of this motor is such that the motor will run in either direction, depending upon the polarity of the off-balance d-c between the thermocouple and the measuring circuit. To prevent overshoot or coasting of the motor, the same network which is used as a filtering means is used as a damping means. The basic connections of this type circuit are shown in Fig. 29.

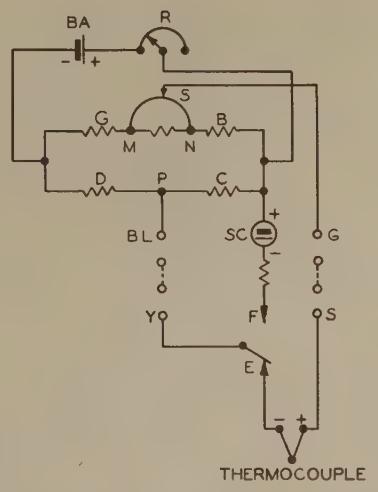

Fig. 29—Simplified wiring diagram of potentiometer type measuring circuit.

The battery BA supplies a continuously flowing current to the potentiometer circuit, the current being maintained practically constant by adjustment of the rheostat R. As the voltage of the battery BA changes, the current in the potentiometer circuit will also change. To compensate for this change a portion of the battery voltage is compared, at intervals, with the constant voltage of the standard cell SC and the rheostat R is adjusted until the proper current is flowing in the potentiometer circuit. This is accomplished by completing the circuit at the point F. If the voltage across coil C is not equal to the voltage of the standard cell, the balancing motor will adjust rheostat R until a balance is obtained. The two voltages will then be equal and opposite, and the proper current will be flowing in the potentiometer circuit.

The unknown electromotive force is measured by completing the circuit at E and moving the contact S along the slidewire MN until the balancing motor does not operate (balanced). Then the electromotive force of the potentiometer across PS is equal and opposite to the electromotive force being measured.

Automatic compensation for the reference junction temperature of the thermocouple is obtained with the coil D, which is located at the reference junction. The resistance of this coil varies with the reference junction temperature. This causes the electromotive force of the potentiometer across PS to automatically vary and exactly compensate for any change in the electromotive force of the thermocouple due to a change in the reference junction temperature.

The rheostat R is operated automatically or semi-automatically and the connections at E and F are made automatically or semi-automatically.

A typical measuring circuit diagram is shown in Fig. 31. A separate wiring diagram is furnished with each recorder showing the exact connections for each specific installation. This latter diagram should be used for checking a given installation.

The connections shown in Figs. 29 and 31 are for a single-point curve drawing recorder. The essential difference between the curve drawing and multiple-point recorder is the addition of a selector switch in the thermocouple circuit to select one couple at a time for recording.

A typical measuring circuit for a multiple-point recorder is shown in Fig. 32.

B. Resistance Measuring Type

The measuring circuit of this type of recorder is fundamentally a Wheatstone bridge with a filtering and damping circuit as part of the amplifier detector. The d-c off-balance of the bridge is passed through the filter to eliminate any a-c pick-up in the Thermohm® leads and is fed through a synchronous vibrator type converter and an input transformer. The output of this transformer is applied to the grid of the first tube in the a-c amplifier in the form of an a-c signal. This signal is then passed through three stages of amplification to a power tube which in turn controls a 2-phase motor that drives the measuring circuit slidewire. One phase of this motor is connected across the line and the second phase or the control winding, is energized by the amplifier. The phase relationship between the two windings is such that the motor will run in either direction, depending upon the polarity of the off-balance d-c of the bridge. To prevent overshoot or coasting of the motor, the same network which is used as a filtering means is used as a damping means. The basic connections of this type circuit are shown in Fig. 30.

The slidewires S and S_1 are mounted on the same shaft, and therefore, rotate together. The resistances of these slidewires are so proportioned and the contacts V and V_1 so arranged, however, that no matter what position the contacts V and V_1 assume on the slidewires, the resistance of the arm VV_1 is always equal to the resistance of the arm V_1A_1. The bridge, therefore, is brought to balance by moving contact V along slidewire S until the resistance of arm VRC is equal to the resistance of T (the Thermohm). With this circuit arrangement, the resistance of the leads

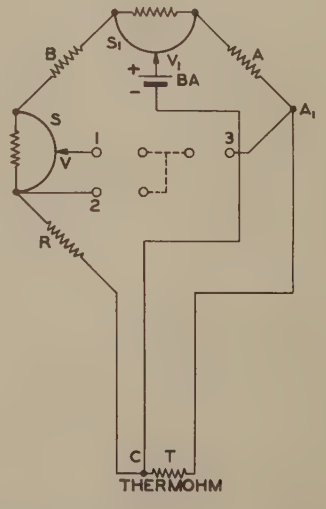

Fig. 30—Simplified wiring diagram of Wheatstone bridge type measuring circuit.

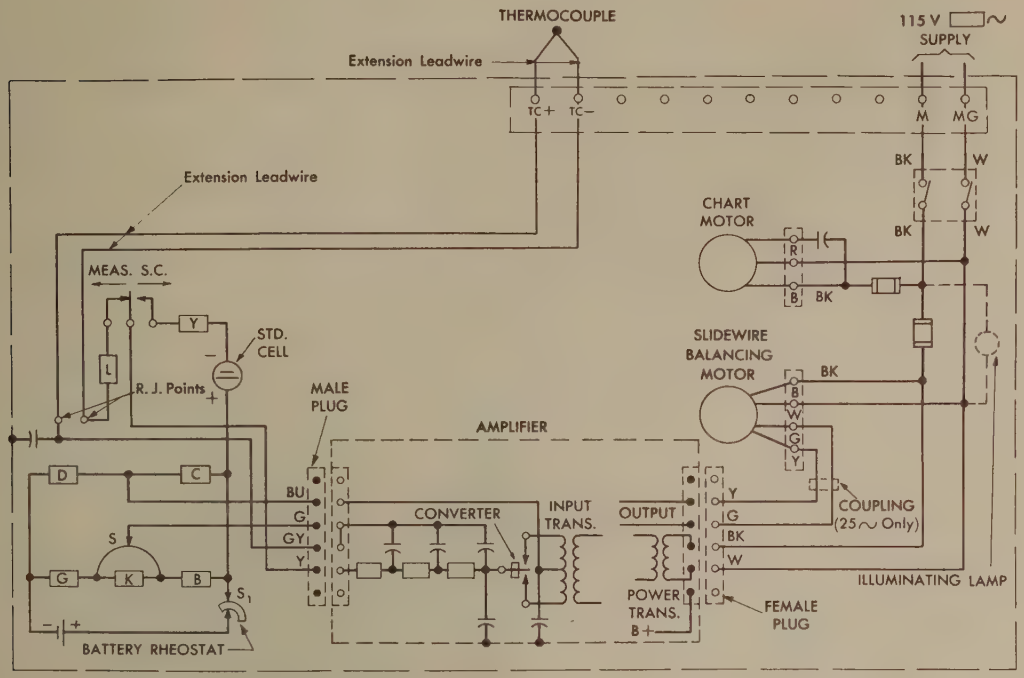

Fig. 31—Schematic wiring diagram of standard, single point, potentiometer type recorder.

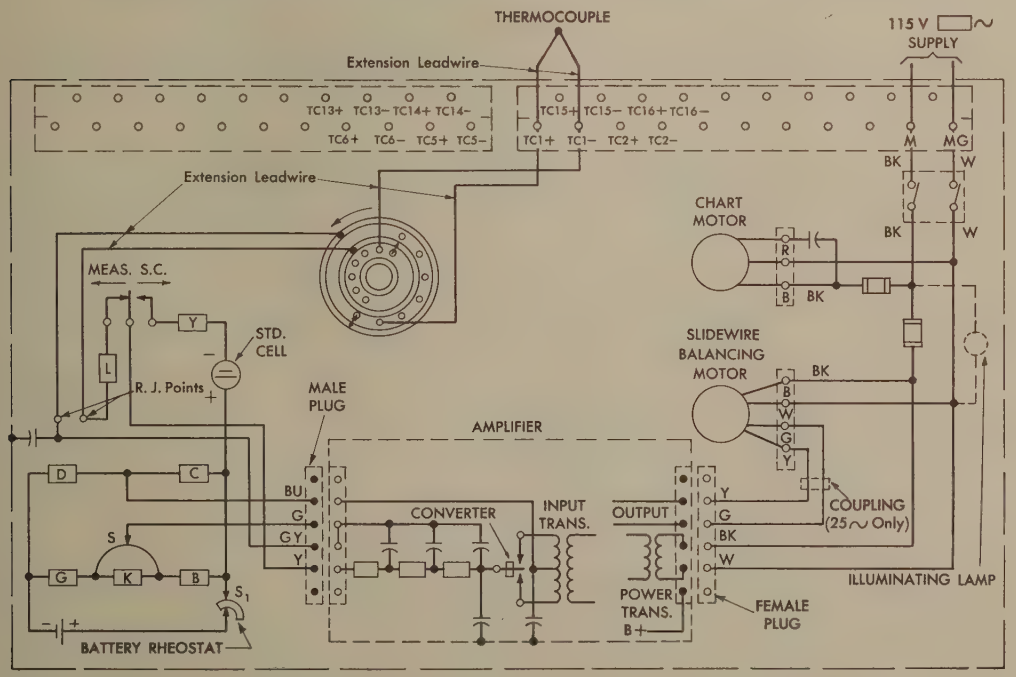

Fig. 32—Schematic wiring diagram of standard, multipoint, potentiometer type recorder.

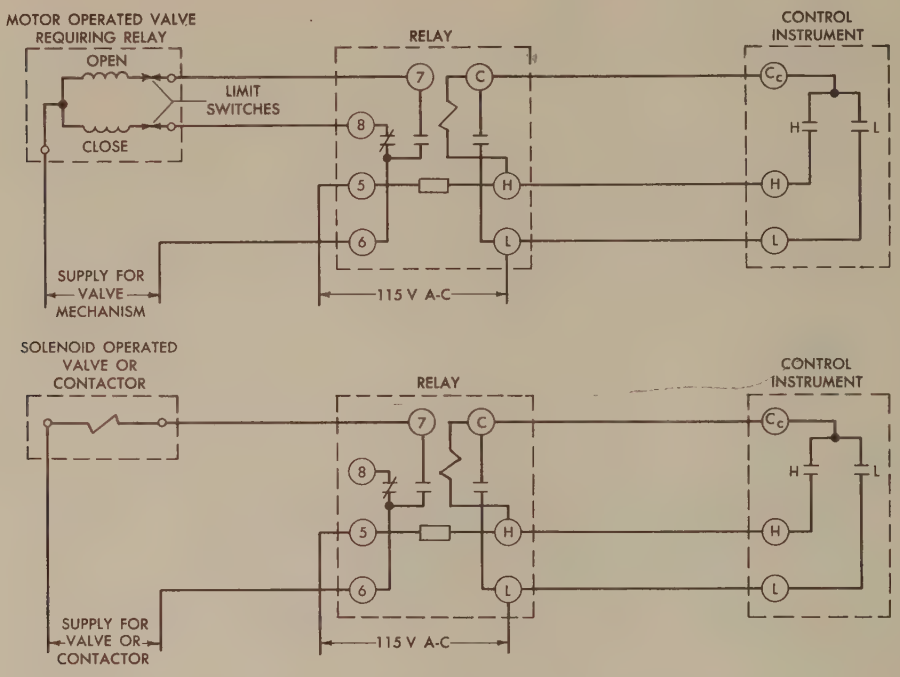

Fig. 33—Typical wiring connections for Std. 12709-3-□ Thermostatic Relay.

from R to T and from A_1 to T has no effect on the reading, providing these leads are of equal resistance.

Note should be made of the fact that the sliding contacts V and V_1 are not directly in the measuring circuit, but are in the amplifier detector and battery circuits, where variation in resistance will have no effect on the accuracy of the reading.

The slidewires S and S_1 are operated by the balancing motor, while the direction and magnitude of the rotation of the slidewire is governed by the polarity of the off-balance d-c of the bridge.

A separate wiring diagram is furnished with each recorder showing the exact connections for each specific installation. This diagram should be used for checking a given installation.

42. WIRE COLOR CODING

The internal wiring of standard potentiometer type recorders is made with color coded wire to assist in identifying the connections. These recorders may be single-point (continuous curve drawing) or multiple-point (number curve printing). This coding is shown by letters in the separate diagram for each recorder with the letters signifying the colors as follows: BK-black, W-white, R-red, G-green, GY-gray, BU-blue, Y-yellow.

43. THERMOSTATIC RELAYS

The diagrams in Fig. 33 are included to show typical connections for thermostatic relays used to control either a motor operated valve or a solenoid operated valve. Both arrangements are suitable when using single-point recorders. When multiple point recorders are used, thermostatic relays must not be connected to adjacent points. If adjacent points must be used an "alternate dead stud" selector switch is to be specified for instruments up to 12 points. Above 12 points, a third selector switch must be specified, also with "alternate dead stud" feature.

In some cases these special selector switches can be avoided by using mechanical latch-in relays. Such a setup is less expensive, but these relays will not reset in case of power failure.

A separate diagram is furnished with each recorder showing the exact connections for each specific installation.

44. REPLACEMENT PARTS

A separate parts list for these recorders is available as, Parts Catalog P-ND46(1), and can be obtained from Leeds & Northrup Company.

APPENDIX

RECOMMENDED SPARE PARTS FOR STANDARD RECORDERS

FOR ALL RECORDERS

L&N Part No.	Description	Quantity Per Instrument
Std. 3246-113	Cartridge Fuse, 3 ampere	2
R-10503-Q	Spring Washer for paper drive	1
R-503-Y	Thrust Washer for paper drive	1
R-503-W	Spring for reroll friction	1
027096	Retainer clip for worm	2
R-25-D	Drive Cord (pen, print wheel or contact setter)	2
R-10802-X	Split Gear Assembly	1
R-510-Q	Spring Washer for split gear clutch assembly	3
R-815-L	Ball Bearings for main shaft	2
27-3-3-2	Bearing Retainer Ring	1
017138	Balancing Motor, 50/60 cycles	*
R-346-32-25-R	Balancing Motor, 25 cycles	*
017209	Chart Drive Motor, 50/60 cycles	*
R-346-2-25	Chart Drive Motor, 25 cycles	*
R-30815-T	Slidewire Contact Assembly (2 contact type)	*
029495 **	Slidewire Contact Assembly (4 contact type)	*
008052	Bearings for balancing motor, 50/60 cycles	*
8-2-3-2	Bearings for balancing motor, 25 cycles	*
008024	Bearings for chart drive motor, 50/60 cycles	*
R-346-V-4	Bearings for chart drive motor, 25 cycles	*
△	Converter for amplifier	1
△	Fuse for amplifier	1
△	First Voltage Tube for amplifier	1
△	Second Voltage Tube for amplifier	1
△	Power Tube for amplifier	1
△	Rectifier Tube for amplifier	1

*Exact quantity, if any, to be determined by customer on the basis of the number of recorders in service.

**029495 replaces the previously used R-20815-AM (Single Unit Assembly) and also replaces the 29-5-0-8 (Adjustable Position) and 29-5-0-9 (Fixed Position) Contact Assemblies which were subsequently used in combination.

△Use the tube number marked on the amplifier chassis.

FOR SINGLE-POINT RECORDERS ONLY

L&N Part No.	Description	Quantity Per Instrument
R-10504-M	Standard Bore Pen for "Across the Chart" speeds of 3 sec. (nominal) or more	1
R-504-M-2	Wide Bore Pen for "Across the Chart" speeds of less than 3 sec. (nominal)	1
R-604-G	Stopper for glass pens	1

FOR MULTIPLE-POINT RECORDERS ONLY

L&N Part No.	Description	Quantity Per Instrument
R-504-EX	Spring for crank lever	1
R-504-EY	Spring for printing lever	1
R-504-GK	Ratchet Stop Spring	1
R-504-GW	Spring for pawl	1
R-20504-BR-□[1]□[2]	Print Wheel Unit	*
- - - -	Multipoint Switch Assembly:	1
R-511-12	For 2, 3, 4, 6 or 12 points	-
R-511-10	For 5 or 10 points	-
R-511-16	For 8 or 16 points	-
R-511-20	For 20 points	-
R-511-R	Plunger	2 ☒
R-511-S	Compression Spring	2 ☒
R-511-T	Wire Clip	2 ☒
R-511-U	Contact Brush	2 ☒

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*Exact quantity, if any, to be determined by customer on the basis of the number of recorders in service.

□[1] In the first box, as a suffix, specify the number of points, i.e., 2, 3, 4, 5, 6, 8, 10, 12, 16, 20.

□[2] In the second box, as a suffix, specify type size, i.e.,

A = 0.0621 (Standard) C = 0.0828 (Average)
B = 0.0414 (Undersize) D = Dots only

☒ For Nos. 61352 to 61370 and 61452 to 61470 Thermohm Recorders, these quantities should each be (3) three.

FIELD OFFICES

ALBANY	Union 9-9079
ATLANTA 5, 3084 Grandview Ave., N. E.	Cedar 7-8624
BALTIMORE, 311 E. Penna. Ave., Towson 4	Valley 5-7710
BATON ROUGE	Walnut 4-4471
BOSTON 66, 430 Lexington St., Auburndale	Lasell 7-9360
BUFFALO 15, 3685 Harlem Road	Atwater 8900
CHICAGO 1, 307 N. Michigan Ave.	Central 6-3428
CINCINNATI 36, 8005 Plainfield Rd.	Sycamore 1-2274
CLEVELAND 6, 1922 E. 107th St.	Sweetbriar 1-5100
COLUMBUS 12, 1465 Northwest Blvd.	Hudson 6-7146
DAVENPORT	Davenport 5-5433
DENVER 2, 1545 Glenarm Place	Acoma 2-1808
DES MOINES	Cherry 3-6081
DETROIT 35, 18240 James Couzens Highway	Diamond 1-2320
E. ORANGE, N. J., 99 Washington St.	Orange 2-3420
GRAND RAPIDS	Glendale 4-2161
HARTFORD 17 (West), 2535 Albany Ave.	Adams 2-4474
HOUSTON 27, 3939 Essex Lane	Mohawk 7-7481
INDIANAPOLIS 18, 3513 N. Hovey St.	Walnut 6-2462
KANSAS CITY 14, 7935-A1 State Line Rd.	Jackson 3-8199
LOS ANGELES: 1190 Monterey Pass Rd., Mont. Pk.	Angelus 9-3191
MILWAUKEE 2, 828 North Broadway	Broadway 2-1016
NEW YORK 17, 711 Third Ave.	Murray Hill 7-4133
PHILADELPHIA: Ft. Washington, Pa.	Mitchell 6-5500
PITTSBURGH 34, 300 Mt. Lebanon Blvd.	Locust 1-7808
PORTLAND, Ore.	Capitol 8-1604
RICHMOND, Va.	Milton 4-8379
ST. LOUIS 5, 8000 Bonhomme Ave., Clayton	Parkview 6-0853
SALT LAKE CITY 11, 455 E. 4th, South	Davis 8-8861
SAN FRANCISCO 3, 1095 Market St.	Market 1-3464
SEATTLE 9, 1311 Republican St.	Main 3-5505
TULSA 3, 8 E. 4th St.	Gibson 7-3720
WASHINGTON, D. C.	Enterprise 1-6150
WINSTON-SALEM	Park 3-0693

Main Offices: 4901 Stenton Avenue, Philadelphia 44, Pa.
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